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# THE HARVARD–DARTMOUTH ALASKAN EXPEDITIONS, 1933–1934: *A paper read at the Evening Meeting of the Society on 3 February 1936, by*

H. BRADFORD WASHBURN, Jr.

*In conjunction with the paper read at an Additional Afternoon Meeting of the Society on 6 February 1936, by Richard P. Goldthwait*

ONE hundred and fifty miles west of Juneau and about the same distance south of the massif of Mount Saint Elias a magnificent but little-known range of mountain peaks rises from the icy waters of the Gulf of Alaska. Paralleling the Pacific coast and extending southward for a distance of some 50 miles from the delta of the Alsek river, the Fairweather range may well be classed as one of the highest groups of coastal mountain peaks on the face of the earth. The history of the exploration of the Fairweather peninsula is at the same time varied and intensely interesting. As early as 1778 (June 3) [1] that immortal British navigator, Captain Cook, was the first man to record the existence of the Fairweather range, during the course of one of his long voyages in the Pacific. Shortly afterward the great French explorer, La Perouse,[2] not only sighted the mountains from out to sea but made the first actual landing in the beautiful fjord-like harbour of Lituya Bay, which he found to be inhabited by a degenerate tribe of coastal Indians. Here he stopped for several days (July 2–August 1) in order to rest his men and to replenish his ships with fresh water and fish before continuing along the coast in his quest for the North-West Passage. This visit of La Perouse in 1786, short as it may have been, has left an indelible mark on the Fairweather country. Mount Fairweather (*Mont Beautemps*), Cape Fairweather, Mount Crillon, Mount Dagelet, and Mount La Perouse form a curious little knot of French names amidst the mass of Russian and Indian nomenclature predominant throughout coastal Alaska.

The first truly scientific visits to the region about Lituya Bay were made by a party of the United States Geological Survey in 1917 and by the Coast and Geodetic Survey and Forest Service in more recent years (1926 and 1929 respectively). The first of these three visits lasted for but a few days and

[1] 'Cook's Last Voyage,' vol. 2, 1784, pp. 345–6.

[2] La Perouse, 'A Voyage Around the World,' vol. 1, London 1799, pp. 364–416.

resulted in a short paper on the geologic reconnaissance of the immediate surroundings of the bay by H. S. Mertie, Jr. The Geodetic Survey party executed a precise traverse along the coast-line from Icy Point to Lituya Bay and later made a detailed map of the bay and a chart of its waters. In 1929 the Forest Service made three short aerial mapping flights for the purpose of studying the forests of the coastal area and for accurately recording the positions occupied at that time by the ice-fronts of the glaciers at the head of Lituya Bay and Crillon Lake.

In the spring of 1926 a mountaineering expedition composed of three members of the American Alpine Club (the late Allen Carpé, Dr. William S. Ladd, and Andrew M. Taylor) made an attempt to reach the summit of Mount Fairweather (15,318 feet), and it was at this time that the intensive exploration of the west coast of the Fairweather range may be said to have commenced. Shortly after this first mountaineering expedition, in the summer of 1930, a party of six graduates and undergraduates of Harvard University, led by the author, traversed the 25-mile course of Desolation Valley, an ice-filled glacial trench extending north-westward from the head of Lituya Bay to the very foot of Mount Fairweather, and made a new effort to scale this stunning and extremely difficult virgin peak. Abominable weather and a shortage of supplies forced this second expedition to retreat after having reached an altitude of but 6500 feet on the main body of the mountain, 3000 feet lower than the height attained by the 1926 party. In 1931 the Carpé, Ladd, Taylor, Moore party followed a new route along the ocean beach north of Lituya Bay and thence inland over the Fairweather Glacier to the base of the mountain. Starting early in April, this group of men finally succeeded in conquering Mount Fairweather by its redoubtable south-west ridge, after a desperate seven-weeks struggle with rainstorms, blizzards, and westerly gales. The ascent of this great peak still remains one of the outstanding achievements of mountaineering in America.

During the summers of 1932, 1933, and 1934 a series of three expeditions, mostly composed of men from Harvard University and Dartmouth College,[1] carried out a varied programme of mapping, glacial research, and exploratory mountaineering in the massif of Mount Crillon (12,728 feet), the second highest of the isolated peaks of the range, which lies several miles south-east of the head of Lituya Bay. During the course of this work two aerial photographic flights, financed in part by the Geological Society of America, were made by Mr. Richard P. Goldthwait for the purpose of recording the present ice-front positions of the glaciers of Yakutat Bay, about 100 miles north of Mount Crillon, and for studying the amazing morainic bandings of the Malaspina Glacier, which stretches seaward in an immense piedmont fan from the base of Mount Saint Elias.

Detailed accounts have been published elsewhere which tell the story of the long struggle that was finally rewarded by two ascents of Mount Crillon by three members of the last expedition on 21 and 29 July 1934.[2] A new

[1] Led by Mr. Washburn.

[2] See *Appalachia*, June 1934; *American Alpine Journal*, 1934, pp. 148–155; *The Alpine Journal*, 1933, pp. 135–140; *Alpinisme*, 1935; *National Geographic Magazine*, March 1935 (the most complete account of the mountaineering and photographic flights).

expedition to study the geology and glaciology of the eastern approaches of the Crillon massif is being planned for the near future.[1] It is the purpose of this article to describe, in as much detail as space allows, the purely scientific accomplishment of the last two of the three Harvard-Dartmouth expeditions, the 1932 party having devoted almost its entire seventy-day stay in the mountains to a thorough reconnaissance of the entire western side of the Crillon massif in order to lay a firm foundation for more specialized future field work.

*Topography*.—The material used in the preparation of the reconnaissance map of Lituya Bay and Vicinity published in this issue of the *Geographical Journal* was obtained from two important sources other than the field work of our expeditions of 1933 and 1934. In 1926, as outlined in the introduction, the United States Coast and Geodetic Survey ran a precise traverse along the coast-line from Icy Point (where the Cape Spencer–Icy Point Triangulation ended) to Eagle Creek, a point on the beach some 4 miles north of Lituya Bay. A precise base-line was measured on the spit just north of the mouth of Lituya Bay and a triangulation speedily expanded from stations South Base and North Base on the spit to embrace the whole of the bay. Many other triangulation stations (Cove, Harbour Point, Li, Tu, Ya, Cliff, Ice, and Berg) were occupied around the shores of the bay and an excellent map and chart of the waters of the bay prepared from the results of this work. No vertical angles whatsoever were observed during the course of this geodetic survey work, but many rays were taken on the summits of Mount Crillon and Mount La Perouse, corroborating the positions of these peaks as established by the International Boundary Commission from Glacier Bay, 25 miles to the east, on the other side of the range.

In July and August 1929 the United States Forest Service made a series of three photographic mapping flights along this part of the coast. These flights were a part of a huge government mapping programme of that year, which photographed almost all of the major islands and glacier fronts along the coast of south-eastern Alaska from Ketchikan to Lituya Bay. These photographs were taken with a tri-lens camera and were subsequently mounted on cards in groups of three, the two "wing-prints" of each group having been properly adjusted for tilt in a transforming printing machine.

During the summers of 1932 and 1933 our survey party reoccupied a sufficient number of the U.S.C.G.S. stations at Lituya Bay to eliminate the necessity of measuring a base-line for our own work. Utilizing South Base, Cove, Li, and the summit of Mount Crillon as initially fixed points, a new station was established on Bald Mountain, one of the rolling coastal hills 3 miles south of Lituya Bay, in a belvedere from which almost every peak of the whole Fairweather range was clearly visible. Rounds of vertical and horizontal angles were read with extreme care on both faces of a Wild theodolite for primary triangulation and, in the case of the altitude of Mount Crillon, which was the only accurately pre-determined elevation in our area, the mean of our computed heights of 12,726 and 12,730 feet resulted in a figure of

[1] The geological report is to be withheld until field work on the eastern side of the range permits publication of a complete and comprehensive paper on the whole southern end of the massif.

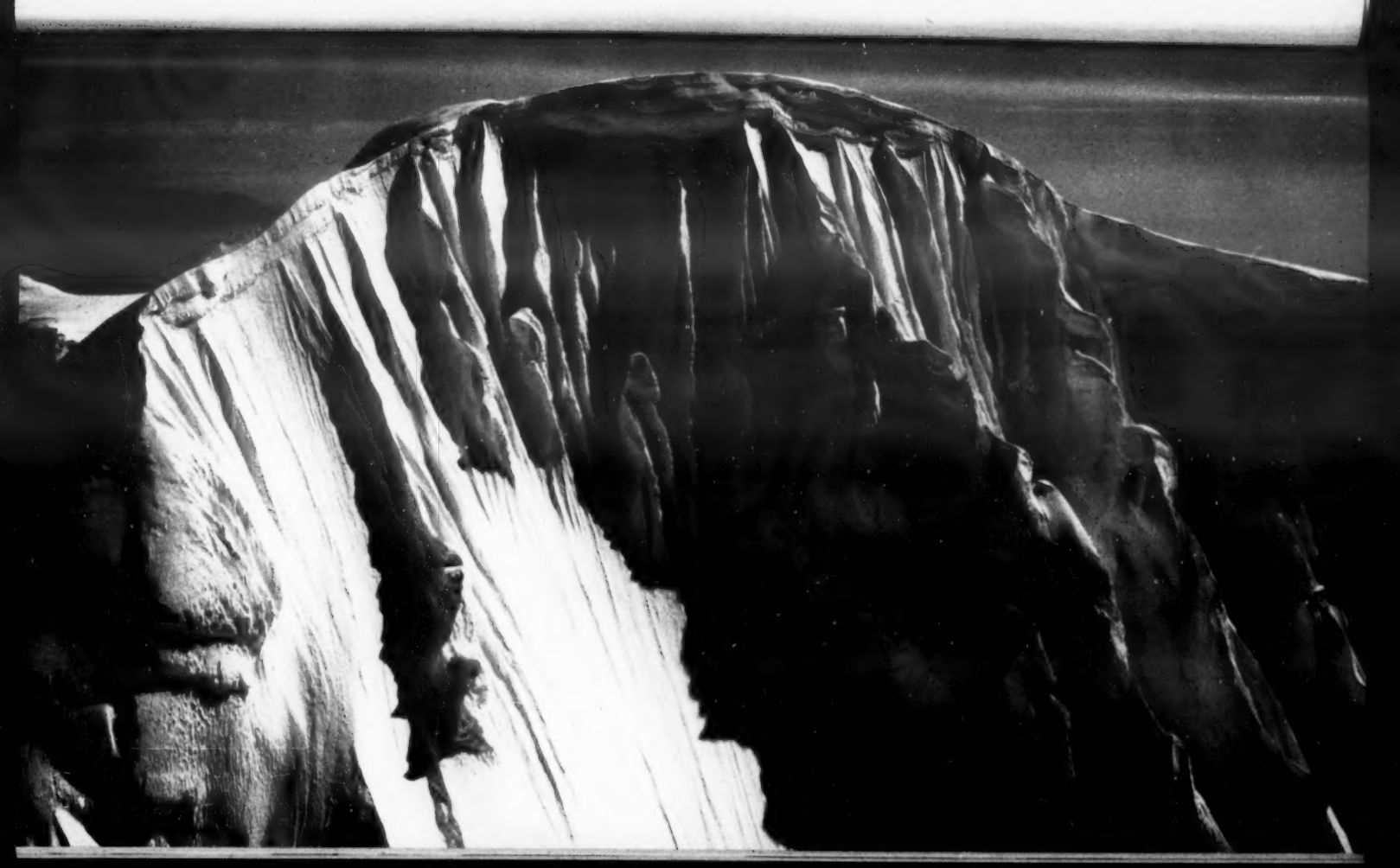
12,728 feet as compared with the 12,727 feet determined by the Boundary Commission from Glacier Bay nearly twenty years before.

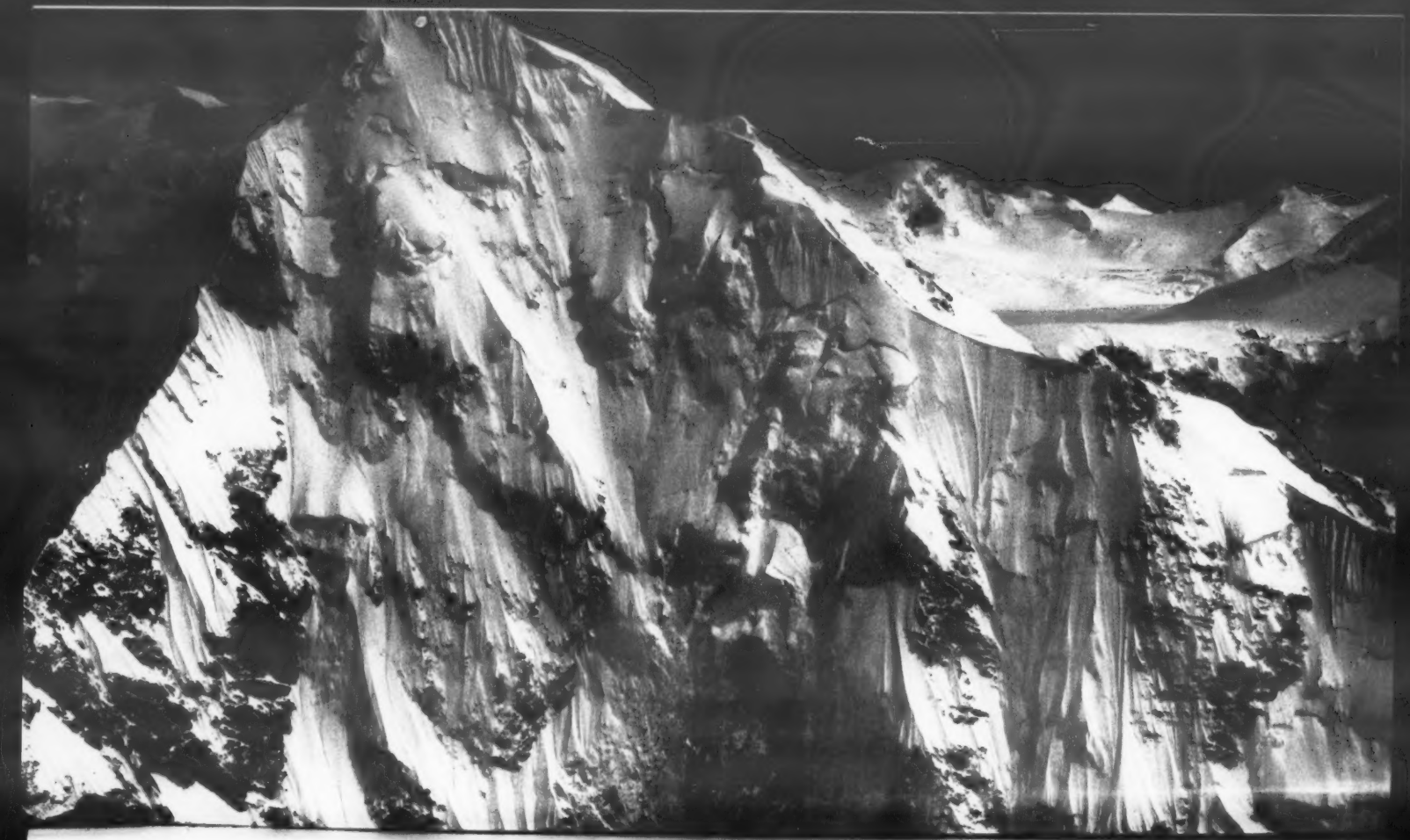
This triangulation was rapidly extended from Lituya Bay and Bald Mountain, by means of advanced stations on Cairn Peak, Ptarmigan Dome, and North Dome, until the position of every one of the major and minor peaks shown on the completed map had been fixed both for position and altitude. The final altitudes were checked by a comparison of heights as calculated for the same point from two or more of these triangulation stations and the final results were in all cases found to agree within an error-limit of about 25 feet.

Topographic detail in the upper reaches of the Crillon massif was filled in about fixed triangulation points, partly by aneroid "spot-heights" made at frequent intervals by the climbing party while it was on the mountain, and partly by careful sketching from a comprehensive series of oblique aerial photographs mostly taken by the 1934 expedition with a Fairchild "F–8" Aerial Camera of 10 inches focal length. A base-line was measured near the base camp of the 1933 and 1934 expeditions on the north shore of Crillon Lake, and a subsidiary triangulation was made of this body of water which fell in the outermost extremities of the "wing-pictures" of the coastal strip of Forest Service aerial photographs. The fixed points of this small triangulation were used to adjust the outline of the lake, which, due to its unfortunate position on the aerial photographs, had been badly distorted from camera tilt. Under the direction of Mr. Goldthwait, detailed soundings were made of Crillon Lake in order to determine the extent of Pleistocene ice-scouring in the lake-trough by the masses of South Crillon, Lookout, and Klooch Glaciers in their prehistoric advanced state. The profile of the bottom throughout the entire length of the lake was found to be the perfect "U" so typical of once-glaciated valleys. The maximum depth was 640 feet, measured scarcely 150 yards off the south shore about half-way down the length of the lake. It is of great interest to note that, since the surface of this lake is known to be but 315 feet above the sea, its depth places its bottom well over 300 feet *below* tide water-level.

The details of the coastal topography, the final coast-line, and the complex system of meandering canyons that descend the low coastal hills to the sea, have been determined from the Forest Service aerial photographs by the method usually employed in multiple-lens photographic mapping. A "radial-line plot" was prepared from all of the strip of photographs which overlapped one another from 50 to 60 per cent. A "control sheet" indicating the true positions of all of the Coast and Geodetic Survey traverse stations along the beach was prepared on as nearly as possible the same scale as that postulated by the focal length of the lens of the camera used in the mapping and the flight altitude of the aeroplane which took the picture. The radial-line plot was adjusted to conform with the ground control as it was recognized on the photographs. The altitudes of moraines, old marine terraces, ponds and creek intersections were obtained from aneroid heights recorded at all of these points visited by either topographic or geologic parties during the summer of 1934, using as a base-map the outline compiled from the aerial photographs in the winter of 1933–34. This method of mapping provided a

*The crest of Mount Crillon from ¼ mile N.W. of the summi*
*Fairchild Aerial Camer*





speedy and very accurate system for filling in even quite minute detail in an area along the coast which was so flat and heavily wooded that plane-tabling would have been next to impossible unless traverses had been run along the course of every creek bed. After the courses of the streams, their altitudes and those of the minor coastal hills and terraces had been plotted on the map in this fashion, the contouring of the coastal country was completed by studying the aerial photographs closely under the stereoscope.

The completed map is, as it stands, a sheet of approximately "reconnaissance survey" value. It has been prepared rather to illustrate and to accompany the reports on the glacial and geophysical research of the expeditions than as an end in itself. I feel it of utmost importance here to convey our deepest gratitude to Dr. A. Hamilton Rice, whose kind assistance in the loan of valuable instruments and in permitting the final map to be compiled at the Institute of Geographical Exploration at Harvard University made possible the completion of this important part of our work. I wish also to extend especial thanks to the Fairchild Aerial Camera Corporation of Woodside, Long Island, for the loan of a superb aerial camera with which all of our oblique photographs were taken (see Folding Map at the end of the *Journal*).

*Complex Morainic Bandings.*[1]—Controversy has long centred in geological circles about the problem of glacial motion and the true physical properties of glacial ice. Professor Rollin T. Chamberlin, of the University of Chicago, has shown by experiment [2] that glacial ice, when subjected to shearing stress, can be faulted and overthrust in the same manner as rock. On the other hand, the late R. S. Tarr and Professor O. D. von Engeln, of Cornell University, have persistently maintained [3] that glaciers, although composed of ice which is obviously a crystalline solid, nevertheless exhibit the characteristics of a plastic or viscous type of flow, easily adapting themselves without rupture to the irregularities of the terrain over which they pass. H. Hess [4] has recently reopened the discussion by championing the theory of plastic flow.

Observation in the Alps and in Alaska and several recent conferences with Professor Chamberlin have led me to believe that, in all probability, glacial ice behaves in *both* of these ways. Not one of the glaciers which I have visited during my field experience has failed to show clearly a plastic adaptation of its shape to its surroundings. This experience also leads me to the conviction that the greater the extent of a glacier the more marked are the signs of its plasticity; although shearing and thrusting, to a greater or less (sometimes minute) degree, seem to be invariably associated with all glaciers. On 23 August 1933, in the course of an airplane flight which had for its purpose the relocation of all of the ice-fronts of the glaciers of the coastal region of south-eastern Alaska between Cape Spencer and Icy Bay, both Mr. Gold-

[1] Adopted from report of this field work published in the Bulletin of the Geological Society of America, vol. 46, pp. 1879–90.

[2] R. T. Chamberlin, "Instrumental Work on the Nature of Glacial Motion," *Journal of Geology*, vol. 36 (1928), pp. 1–30; and "Glacier Movement as Typical Rock Deformation," *Journal of Geology*, vol. 44 (1936), No. 1.

[3] R. S. Tarr and O. D. von Engeln, "Experimental Studies of Ice with Reference to Glacier Structure and Motion," *Zeitschrift für Gletscherkunde*, translated, Bd. 9, Heft 2 (1915), pp. 81–139.

[4] "Das Eis der Erde," *Handbuch der Geophysik*, Bd. 7, Lief. 1, Berlin (1933).

*N.W. face of Mount Crillon from 11,000 feet*
*Fairchild Aerial Camera*

thwait, my companion, and myself were deeply impressed by the extraordinary deformation of the morainic systems of the huge Malaspina Glacier.

It would be impossible to overestimate the value of the aeroplane to Alaskan glacial work. In four peaceful hours on this beautiful August afternoon we not only succeeded in photographing every one of the important glaciers along 150 miles of rough Alaskan coast, but we were also able to make an aerial reconnaissance of the whole southern third of the Malaspina Glacier and its tributary valleys—an area that would have required many arduous months to cover much less effectively on foot. When we returned to our camp at Crillon Lake that evening we were certain that we had discovered in the surface of the Malaspina a magnificent new demonstration of the qualities of glacial ice.

Although the Malaspina ice-field has not been studied or traversed for some time, it is one of the best-known glaciers on the continent of North America. Israel C. Russell crossed it during his two attempts to climb Mount Saint Elias in 1890 and 1891.[1] It was crossed by the Duke of the Abruzzi during his conquest of this same mountain in 1899,[2] and it was also visited by the National Geographic Society expeditions under Tarr and Martin during the first decade of the present century.[3] Until our visit however in 1933, the surface of the Malaspina Glacier had never been photographed from the air.

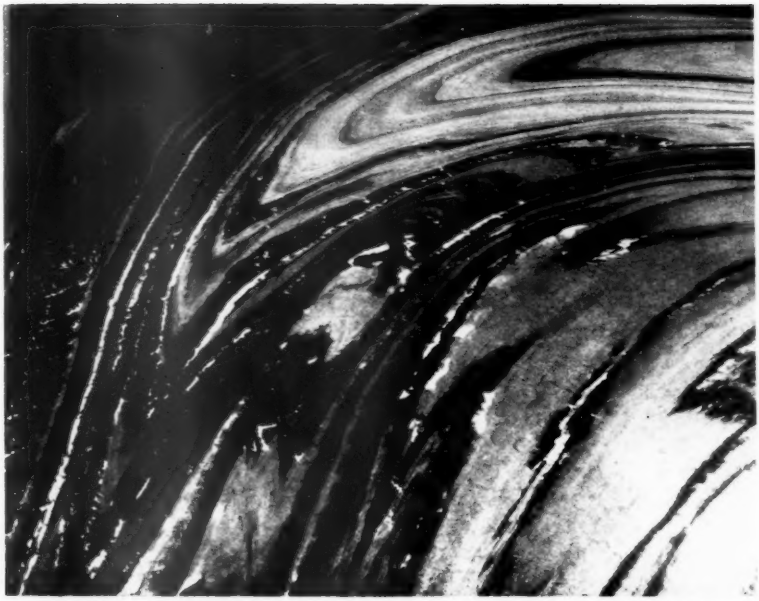
The piedmont type of glacier is most common along the northern coast of South-Eastern Alaska between Icy Point and Cape Saint Elias. Snow accumulated in tremendous volume on the lofty summits of the coast range, most of whose mass is of igneous (intrusive) origin. Valley glaciers descend westward to the coast across a belt of highly metamorphosed schists through which they have cut narrow valleys, some of which are several thousand feet deep. A great fault parallels the coast for a distance of over 100 miles south of Yakutat Bay, separating these schists from the ancient volcanics of the low coastal hills and the overthrust sandstone series of the littoral. Due to considerable marine erosion of these coastal formations and a post-Pliocene uplift of several hundred feet along this part of the Pacific shore-line, one frequently finds coastal-plain areas underlain mostly by shales, conglomerates, and sandstones, which rise gently from the sea toward the base of the main mountain masses. Beyond the point where the glaciers traverse the fault, they are no longer confined to narrow canyons, but spread out in broad, symmetrical fans across the smooth coastal plain. None of these piedmont glaciers, with the exception of the La Perouse just south of Lituya Bay, actually reaches tide-water. Their termini are usually separated from the sea by morainic tracts covered by extremely dense spruce forests or by wide, barren plains of outwash gravel.

The Malaspina is unique among this group of piedmont glaciers in that it is produced by the coalescence of nearly a dozen smaller tributary glaciers,

[1] I. C. Russell, "Second Expedition to Mount St. Elias, in 1891," U.S. Geological Survey, 13th Annual Report, Part 2 (1893), pp. 1–91.

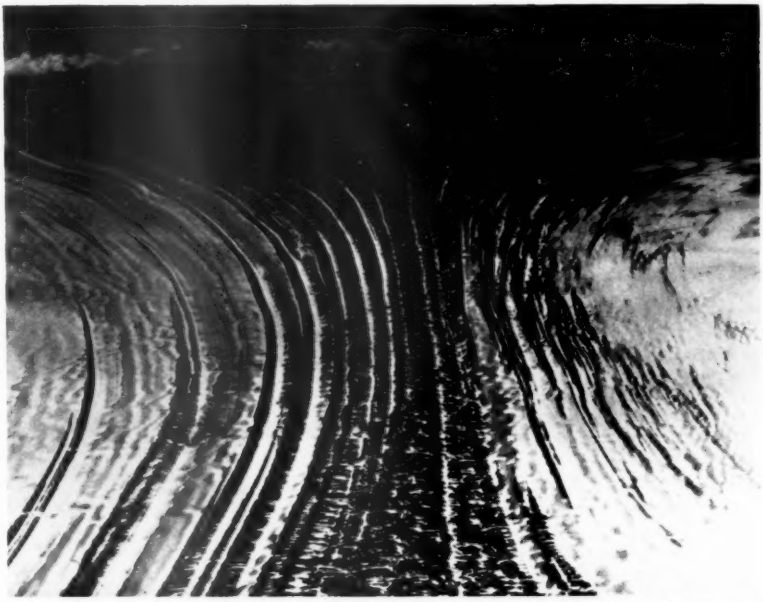
[2] H.R.H. the Duke of the Abruzzi, 'The Ascent of Mount Saint Elias' (1900), London.

[3] Tarr and Martin, 'Alaskan Glacier Studies,' National Geographic Society, Special Publication (1914).



*Fairchild Aerial Camera*

*Air photograph of plastic folding and faulting on the Malaspina Glacier*



*Fairchild Aerial Camera*

*Fan-shaped moraines separating the Malaspina (left) from the Libbey and Agassiz Glaciers (right)*

which pour their contributions of ice through gaps in a range of low coastal hills which lie in a semicircle around the base of the main peaks of the Saint Elias Massif. It may well be referred to as a *compound piedmont glacier*. As a medium for the study of ice-deformation such a composite glacier is ideal. The remarkable convolutions developed in the medial moraines of the tributaries after their unison to form the main mass of the Malaspina are tremendously significant indications of the extremes which may be reached in the plastic flow of glacial ice.

On 12 July 1934 Mr. Goldthwait and I made another flight over the Malaspina, this time working on a research grant from the Penrose Bequest of the Geological Society of America. A careful study of the mass of photographs taken on this second flight, together with two years of Alpine investigations in 1929 and 1931, have furnished a background for the remarks of the next few pages.

*The Medial Moraine.*—Medial Moraines, which result from the union of two or more glaciers to form a *trunk* or *compound glacier*, are, in brief, the superficial expression of the fused adjacent lateral moraines of the two uniting glaciers, and they appear as narrow bands of debris trending roughly parallel to the margin of the trunk glacier. If two glaciers unite above the perennial snow-line, the medial moraine is often deeply buried beneath snow which may be of sufficient thickness to become compacted into a new layer of surface ice, totally obscuring the medial moraine formed at this junction. In the case of the Seward Glacier, the main tributary of the Malaspina, a vast number of medial moraines have been so completely buried in this manner that they do not appear until ablation uncovers them many miles below their sources. This explanation accounts for the origin of many medial moraines which slowly seem to appear on the surface of a trunk glacier. In many cases however this appearance of moraines may be due to the presence of submerged rock masses which project up into the glacier from below. The first expression of any medial moraine is a mere streak of debris on top of the ice. As ablation progresses (4 inches per day in sunny weather on the tongue of the South Crillon Glacier) this streak becomes broader and more continuous, and, as the terminus of the glacier is reached, the material of the medial moraine acts collectively as does a "glacier table," protecting the ice beneath it, and thus develops a high ridge of ice veneered more or less deeply with shattered rocks and gravel.

*Contorted Medial Moraines.*—Slight periodic contortion or deformation of a normally straight medial moraine often occurs in compound glaciers which pass over substantial icefalls. Only a small amount of active avalanching takes place on most icefalls during the winter months, whereas they are very active during the summer. This summer impetus, given the lower mass of the glacier, is likely to result in a zig-zag or wavy pattern in the medial moraine after ablation has re-exposed it some distance below the icefall.

The most extraordinary deformation of any morainic system that I have ever seen is that of the Malaspina Glacier. Here the contortion is not by any means the result of icefalls, but is due, without doubt, to the spasmodic variations in volume and velocity of the tributary glaciers which unite to make up this vast compound icefield. Tarr and Martin, in their 'Alaskan Glacier

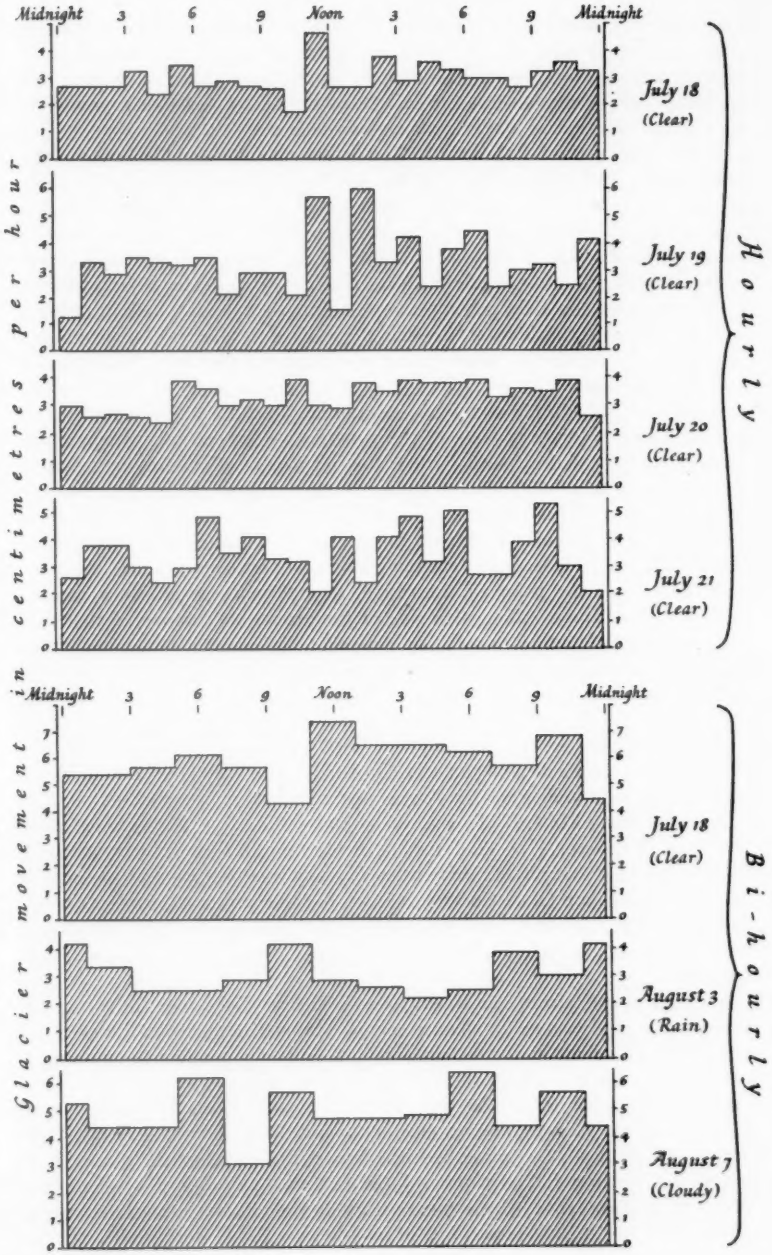
*Junction of tributary glaciers to form a trunk glacier with medial moraines: Mer de Glace in foreground, Glaciers de Talèfre and Leschaux (Alps) in background*

*Fairchild Aerial Camera*

Studies,' have advanced the theory, supported by excellent field evidence, that earthquakes start immense tidal waves of ice moving down the glaciers of this region at irregular intervals. Inasmuch as the length of these tributary glaciers varies widely, an impulse started simultaneously at their heads, either by an earthquake or by some complex climatic factor, would reach their termini at decidedly different times, these times depending directly upon the length and volume of the glacier involved. These spasmodic variations of the source-material of the Malaspina lead to the fantastic distribution of the medial moraines upon its surface. An examination of any of the aerial photographs of these distorted bandings will give the reader, better than words can possibly describe, a clear idea of the immense plastic movements that can take place in the body of a great ice-sheet.

*Faulting in Glacial Ice.*—Faulting in glacial ice is practically impossible to detect unless revealed by the displacement of either morainic bandings or the small "blue bands" of finely crystalline ice referred to in Chamberlin's papers. An important fact not generally appreciated, but of vital significance in the study of the structure and movement of glacial ice, is that medial moraines are not confined to the surface as mere streaks of rocks, but extend to the very bottom of a glacier. In the common case, where two large glaciers with well-defined lateral moraines unite to form a trunk glacier, the medial moraine, viewed in section, is practically vertical and separates the two ice masses. However, when a smaller glacier joins with one considerably larger, the lesser is disposed of in one of two ways. It is either compressed between the larger glacier and the adjacent valley wall until it has been completely destroyed by friction and melting, or it flows out on to the surface of the larger glacier and is carried along by the latter. This latter case, although not encountered as frequently as the former, may be viewed to especially good advantage in Alaska where many glaciers terminate in tidal ice-cliffs and hence afford the observer perfect structure-sections of their ice-mass. The first type of union occurs most frequently when the valley floors beneath both of the joining glaciers are at approximately the same level. The second takes place when a tributary glacier is discharged from a hanging valley into a much over-deepened trunk valley, or when the smaller tributary glacier is still of sufficient volume and power to thrust itself forward and actually up on to the surface of its larger neighbour.

The moraines of the Malaspina are almost entirely of the first type: with the faulting due to subsequent strains and stresses producing dislocations from only one plane—the original vertical plane of the medial moraine. The more complex second type of moraine is excellently developed in the South Crillon Glacier which discharges into Crillon Lake, and on which Mr. Goldthwait carried on most of his geophysical experiments. Immediately below the junction of its two main tributaries the South Crillon Glacier appears, on the surface, much the same as any normal compound glacier, but, on careful examination of a section through both parts of the glacier at its ice-cliff terminus, we discovered a little-known attitude of the medial moraine. It first dropped steeply downward from the surface of the ice, dipping gently in the direction from which the tributary glacier was thrust on to its larger neighbour. It then levelled off, separating the upper or tributary ice from the

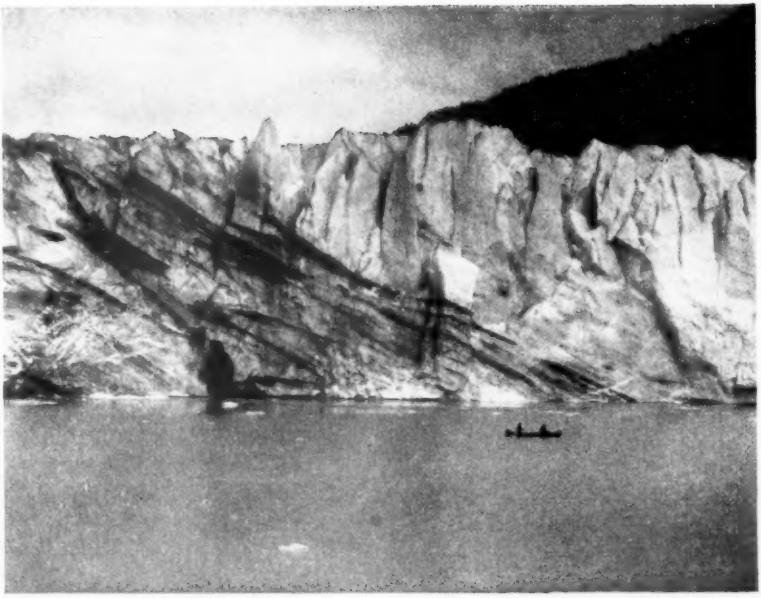

Midnight
3
6
9
Noon
3
6
9
Midnight
Glacier movement in centimetres per hour
July 18
(Clear)
July 19
(Clear)
July 20
(Clear)
July 21
(Clear)
Hourly
August 3
(Rain)
August 7
(Cloudy)
Bi-hourly

lower ice-mass of the main glacier on to which the tributary was discharged. After continuing thus in a horizontal attitude for a short distance (technically here a "ground moraine") it rose steadily until it outcropped once more like another medial moraine near the margin of the ice. I feel that it would be wise to call this type of glacier a *superimposed glacier*.

In the case of the South Crillon Glacier however the contact between the main underlying body of ice and the smaller superimposed mass is complicated by another factor. About a mile before it reaches Crillon Lake this glacier makes a right-angle turn, abruptly changing its direction from west to south. This sharp turn subjects the body of the ice to an immense amount of shearing stress, and much faulting has taken place in the ice adjacent to the contact between the main and superimposed masses. Folds which must have had their origin at considerable depth in the heart of the glacier have developed into clean-cut overthrusts with a throw of several hundred feet. Minor faults and folds, significant of great lateral shearing stress, may be noted in the vertical terminal outcrop of the medial moraine in the ice-cliff at the end of Crillon Lake. Moreover none of the superficial debris scattered along the western margin of the South Crillon Glacier can be classed as true lateral moraine. It is by no means localized to the very edge of the ice, but extends for about 100 yards out on to the glacier's surface. The rock material of which this moraine is composed is entirely foreign to the volcanic valley wall formation at this point. It is almost entirely made up of igneous and metamorphic fragments from the heart of the range, several miles away. By a careful examination of the ice along this side of the glacier we discovered that this rock debris was identical in make-up with that of the ground moraine of the superimposed glacier, and that it had been forced out of the ice and concentrated along its margin by movement along a veritable shingle-block series of low-angle thrust faults. This new type of moraine, which owes its existence entirely to overthrusting, may well be termed a Sheared or Thrust Moraine. Differential movement along one of the major thrusts in this shingle-block series (illustrated in diagram) was measured at over 2 inches per day.

*Hourly Glacial Motion.*—During the summer of 1933, at the suggestion of his father, Professor J. W. Goldthwait, of Dartmouth College, Mr. Richard Goldthwait made a series of observations to ascertain the amount of movement of the South Crillon Glacier over successive bi-hourly intervals for a period of two days. These observations were the most frequent which had ever been made of glacier motion up to that time and raised several decidedly interesting questions.

We had noticed from our base camp on Crillon Lake that three regular periods occurred every day when icebergs were discharged much more frequently than usual from the terminal ice-cliff of the Crillon Glacier at the end of the lake. These periods varied slightly from day to day but took place almost always at the following hours: 12.30–2 a.m., 8–9 a.m., and 3.30–5.30 p.m. A computation of the bi-hourly motion observations of Mr. Goldthwait showed a marked increase in the speed of the glacier just before and during the first part of the last two periods. The maximum bi-hourly motion recorded was 7 cm., while in the minimum-motion periods between these "highs" recordings of as low as 5·4 cm. were made. It was

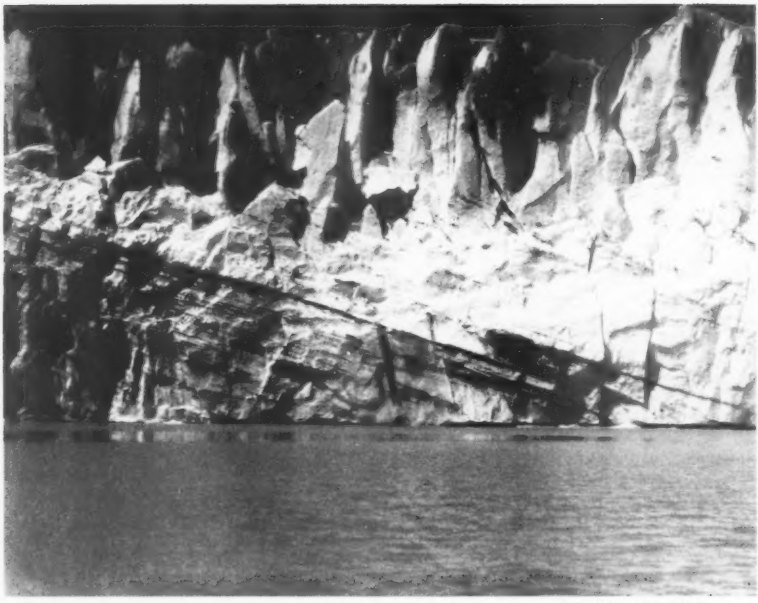


*Fairchild Aerial Camera*

*Clean-cut thrust-faults underlain by shingle-block structure shown below*

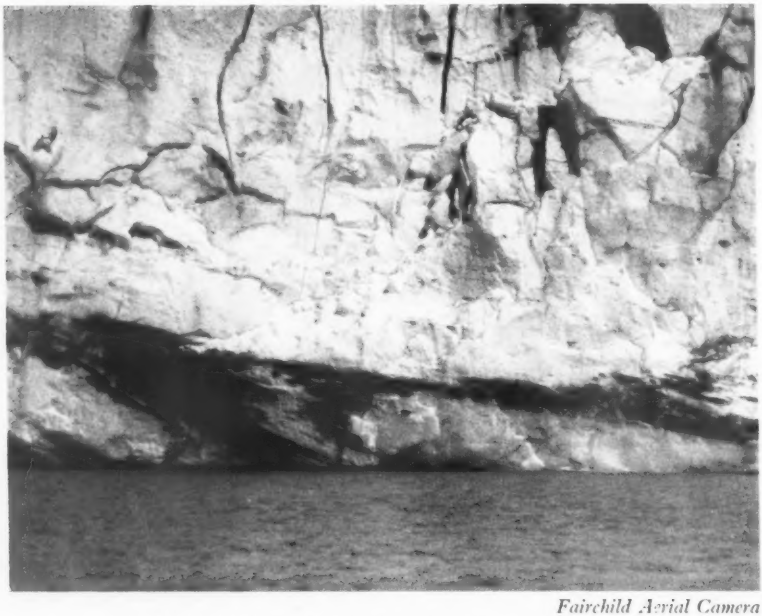
*Fairchild Aerial Camera*

*Ice-front of the S. Crillon Glacier from the lake, showing shingle-block fault structure*



*Fairchild Aerial Camera*

*Thrust-fault developing in the Crillon ice-wall*



*Fairchild Aerial Camera*

*Detail of thrust-faulting in Crillon Glacier wall*

unfortunate that, on account of darkness, observations had to be suspended between 9 p.m. and 3 a.m., which made it impossible to correlate the ice-motion around midnight with the great discharge of bergs that took place at a very early hour every morning.

These observations interested us so much that it was decided to make a new, and considerably longer, series during our stay at Crillon Lake the following summer. We took great care with the installation of the instrument for making the 1934 observations. Dr. Hamilton Rice kindly loaned us a Tavistock Theodolite manufactured by Messrs. Cooke, Troughton and Simms, of London, whose horizontal circle read directly to seconds of arc. We mounted this on a 3-foot cement pedestal erected on a ledge overlooking the surface of the South Crillon Glacier, and several hundred yards from its terminus in order to eliminate any chance of slumping of the ice near its snout affecting the observations. An awning of tarpaulins was erected over the instrument after it had been securely fastened to this pedestal, and a permanent system of electric lighting for night observations was installed, controlled by a switch and a rheostat. We measured a short base-line along the margin of the ice and, from this, determined the distance from our instrument to a specially designed marker that was placed on the surface of the glacier at approximately the point (not quite the centre) where Mr. Goldthwait had recorded the maximum movement the year before. This marker was in the form of a $\frac{1}{2}$-inch brass tube, mounted on a thin brass frame which was in turn screwed securely to the top of a wooden box 18 inches square. This brass tube, which was suspended vertically from its upper end, had an electric-light bulb for night observations attached in its lower end. This inverted mounting prevented the light bulb from being short-circuited by rain, a difficulty which we had experienced while experimenting with a test-marker in a field near Boston. The small brass tube was painted black and observed by day. The filament of the bulb was oriented so that it would appear as a single white line directly below the centre of the tube at night. We painted the box which supported this whole apparatus a dark green so that it would absorb the greatest possible amount of solar heat during the day, thus preventing the formation of a glacier-table under itself that would tilt the marker badly out of adjustment. Even with this precaution it was necessary to make a hasty readjustment of the marker's position every forty-eight hours in order to keep it firm and upright on the ice.

These careful preparations resulted in a successful series of hourly observations made continuously by day and by night from July 17 at 6 p.m. until July 22 at 5 p.m. The weather throughout these initial observations was clear, and the temperature varied only slightly even from day to night (maximum 59° F.; minimum 44° F.). On August 2 and 3 the motion was again recorded, this time during a period of intense rain and heavy fog. From August 6 till August 8 we made a final set of readings showing its behaviour in heavily overcast weather with no rain. Unfortunately, geophysical and topographic duties made it impossible to continue these glacial observations over any more extensive period.

Two features seem to be of paramount importance in a study of the graphs of these hourly and bi-hourly observations: firstly, the curious and constant

periods of increased velocity which occur just after midnight, around breakfast time, at noon time, and again in the late afternoon. Secondly, the amazing effect of prevailing weather conditions on the movement of the glacier.

If we record in order the elapsed movement over succeeding twelve-hour periods of day and night chosen arbitrarily, as shown below, during the clear, warm weather from July 17 till the 22nd, it is of significance to note that, regardless of day or night, there was a steady increase in the rate of travel of the ice throughout all of these periods until the last—and during the afternoon of July 21 the sky began to cloud over.

ACCUMULATED HOURLY MOTION

| *Date* | 6 *p.m.*–6 *a.m.* | 6 *a.m.*–6 *p.m.* |
|---|---|---|
| July 17–18 .. .. | 34·4 cm. | 36·3 cm. |
| 18–19 .. .. | 39·6 | 40·5 |
| 19–20 .. .. | 40·8 | 41·4 |
| 20–21 .. .. | 41·9 | 44·5 |
| 21–22 .. .. | 42·9 | |

This chart would indicate that the average twelve-hourly motion for clear weather was approximately 40 cm. However in the fog and drizzle of August 6 the movement over a similar period had dropped to 29·5 cm., and in the downpour of rain on August 3 it reached an all-time low of 19·4 cm. for a twelve-hour night period—less than half the average velocity in clear weather. It is of utmost importance moreover to point out that these weather variations had no effect whatsoever on the graph-type of the daily glacial motion. The only result of colder or more rainy weather was a general slowing down of the whole mass, with no change at all in the relative speed of the glacier at various times of day.

It would be exceedingly dangerous to try to draw a final conclusion as to the true nature of ice flow from a mere examination of these graphs. Inasmuch as each observation only indicates the amount of motion during the hour preceding that observation, it is impossible to say whether the changes shown on the graphs took place in the form of smooth, evenly balanced crescendos, whether they represent a myriad tiny successive jerks or whether they were the result of only two or three great jerks with intermediate dormant periods. The fact remains that the more frequently the observations are made the more jerky and irregular the graph appears. All indications seem to point to a true glacial flow infinitely less smooth and regular than has been the general belief to date. No matter what the type of flow, it will be extremely hard to explain the far-reaching and almost immediate effect of weather conditions upon so tremendous a mass as the body of a large glacier.

It will remain for future observations of a similar, and, we hope, of a still more precise nature, made in different parts of the world, to solve what promises at best to prove a decidedly knotty problem.

There are innumerable theories which deal with the nature of glacier motion. Probably no single investigation will ultimately decide which of these is valid. Nevertheless the results of such studies of ice banding, ice layering, and ice motion as those which have been presented here may help

*The geophysical equipment on the S. Crillon Glacier*
*Fairchild Aerial Camera*

to pave the way to clearer understanding. The contorted surface of the Malaspina Glacier and the smooth folds seen in the terminal ice-wall of the South Crillon Glacier leave no doubt that glaciers in nature actually undergo the same plastic deformation found in laboratory experiments.[1] Yet on the same Malaspina surface and on the same Crillon ice-front the action of shearing is unmistakably shown by the presence of faulted dirt-bands. It is not easy or necessary to suppose that this folding and shearing occurred at the same time, for frequently a fault may displace the segment of a fold and, for this very reason post-date it. This suggests that folding may predominate at a considerable depth in glacier ice and that fracture is relatively superficial in nature, as in the case of the rock crust of the earth. Since the surface of the South Crillon Glacier melted away at a rate of 4 inches per day in clear summer weather, this outer physical "zone of fracture" must rapidly lower into the "zone of flow" and hence permit evidence of both processes having operated at a single point. Furthermore seismic surveying indicates a sudden change in the physical character of ice at a horizon between 20 and 90 metres below the surface. It is entirely conceivable that this change in physical state marks the lower limit of fracture. Open fractures were not detected to the full depth of this zone; the delay of seismic wave arrival indicates open crevasses from 5 to 30 metres in depth (one-third of the postulated zone of fracture in South Crillon ice). Layering conditions may also be very different in snowfields, where open crevasses are known to extend more than 70 metres below the surface.

It is extremely difficult to determine the nature and extent of "plastic flow" near the surface of the ice. Undoubtedly some sort of adjustment must take place, since the junctions of tributary glaciers invariably result in a beautiful adaptation of the whole compound ice mass, including its surface, to the form of the trunk valley. Yet at innumerable places on the surfaces of mountain glaciers the world over tiny thrust faults have been observed with movements up to several centimetres over periods of a day or two.[2] Some such spasmodic shearing movement is evidenced by the hourly measurements of ice motion near the centre of the South Crillon Glacier. The shorter the period between motion measurements, the more irregular is the curve showing actual ice motion. The theory of physics which glacial geologists will eventually adopt to explain these facts must fit a material which is not always rigid like glass, nor liquid like molten metal, but which is alternately, or in adjacent parts, both rigid and viscous. Glacier ice reacts differently to sudden blows and to prolonged gathering strain. It is a solid close to its melting temperature, which is delicately adjusted to small changes in both temperature and pressure.

[1] R. S. Tarr and O. D. von Engeln, "Experimental Studies of Ice with Reference to Glacier Structure and Motion," *Zeitschrift für Gletscherkunde*, translated, Bd. 9, Heft 2, pp. 81–139, 1915.

[2] R. T. Chamberlin, "Instrumental Work on the Nature of Glacial Motion," *Journal of Geology*, 36 (1928), 1–30.

*The ice-cliff (160 ft.) formed where the S. Crillon Glacier enters the lake*

*Fairchild Aerial Camera*

## DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: We are welcoming here to-night two distinguished American scientists, who have come over here especially to read papers to us, one this evening and the other at an afternoon meeting on Thursday: Mr. Bradford Washburn, who is Instructor in Geographical Exploration at Harvard, and his companion, Mr. Richard Goldthwait. The subject is "The Dartmouth–Harvard Expedition to Alaska, 1932–34." Mr. Bradford Washburn will read his paper to-night and show us some slides and a film; and on Thursday next at a special afternoon meeting we shall have the opportunity of listening to a more technical lecture by Mr. Goldthwait.

It is a great pleasure to have with us Chargé d'Affaires of the American Embassy, Mr. Ray Atherton, who I hope will address us after the lecture.

Finally, as you heard just now, Mr. Bradford Washburn was elected a Fellow this afternoon at a Council Meeting, and it is a great pleasure to be able to welcome him here as such.

I will now ask him to deliver his lecture.

*Mr. Washburn then delivered the lecture printed above, and a discussion followed.*

Mr. RAY ATHERTON: Mr. President, My Lords, Ladies and Gentlemen—The problems that confront the average citizen in the world to-day are so numerous and cast such lengthening shadows before them that it seems to me an especial treat to come here this evening and hear Mr. Bradford Washburn give a most interesting lecture on fields and adventures that lie quite outside everyday life. I do not refer entirely to the new environment that he has shown us but to the new minds, younger from my point of view, that we have been in contact with during the evening, minds whose emphases are quite different from ours. We have, perhaps, to accept as a matter of course the satisfaction of our daily deeds and our daily progress, and to worry about such things as budgets and balances. Well, this new mind, as Mr. Washburn has shown us, is able to take care of its daily needs even on the summit of a mountain; and, quite as it should be, to be free from worry about those other fundamentals of civilization that I have mentioned.

Very fortunately, new environments give us new points of view. I have heard that the first Consul, a young man, that Sweden sent out to Vladivostok many days before the railroad was built, was asked whether on his sledge voyage across Siberia he had not been pursued by wolves. In his enthusiasm for his job, he answered: "Well, just for the first week." I think the enthusiasm and the sporting spirit of that young Swede are also evident in the very sporting efforts of all the young men we have followed this evening on their adventures in the Far North.

For my part, and since I am a Harvard man, I feel a sense of gratitude to Mr. Bradford Washburn for coming here to lecture this evening on this Harvard–Dartmouth expedition, and I owe also many thanks to the Royal Geographical Society for a most charming and pleasant entertainment.

Colonel E. L. STRUTT (President, Alpine Club): I feel I am here in the position of a complete fraud. My only justification for being here is that the nearest point I have approached to Alaska is Ireland to the east and Singapore on the west. But I have one justification, possibly, for finding myself on this platform, and that is that I think—I do not say it is absolutely certain—I am the only honorary member of the American Alpine Club present except the two gentlemen we have heard with such pleasure this evening.

I can honestly say that as President of the Alpine Club and having seen

mountain photographs for the last, certainly, forty years, I have never seen a more superb collection of slides or a more wonderful exhibition of first-class ski-ing over extraordinarily difficult ground. I did not like altogether one or two of the places they climbed on the mountain but I disliked intensely all the places they slid down on skis.

Also as President of the Alpine Club I am going to seize Mr. Washburn, if I can manage to do so, transport him to the Alpine Club, and make him show there that extraordinary collection of things he calls crampons that seem to be more formidable than anything so far produced. They appear to have twenty-five teeth. I only hope that our friend Hugh Ruttledge, who left last Saturday for Everest, is *not* similarly armed.

For many years I have heard about these mountains. As I have said, I have never approached them but I think in congratulating Mr. Washburn on his extraordinarily fine performance and his most interesting lecture, we might call to mind the great feats that young American climbers have performed in past years on these mountains. I refer, first, to the great expedition up Mount McKinley by Stuck many years ago when he made the first ascent. This was followed by a joint American-Canadian expedition resulting in the fall of Mount Logan after one of the most dangerous and arduous struggles so far recorded in mountaineering literature. Then—I know I am rather out in chronological order because I did not anticipate that I should be called upon to speak—the expedition of my friend the late Allen Carpé to Mount Fairweather which, I believe, is one of the greatest feats so far performed in Alaska. And, last but not least, the expedition made by Mr. Charles Houston, accompanied by one of our British members of the Alpine Club, Graham Brown, to Mount Foraker. I understand also that Mount Lucania, one of the mountains Mr. Washburn mentioned, is going to be attacked, also Mount Vancouver of which he showed extraordinary photographs and which I hope will fall to Mr. Washburn and his companions.

The PRESIDENT: Mr. Wordie has seen some of this country. We would like him to add a word or two.

Mr. J. M. WORDIE: I am afraid I have seen Alaska only from sea-level and therefore envy Mr. Bradford Washburn the opportunities which he has had both of seeing the mountains from the air and of making such close acquaintance with them on foot. His achievement is a splendid one, notably for the tenacity which he showed in hanging on for successive years till he obtained his objective and also for the extremely fine photographic record which he has brought back, and which is perhaps the finest ever shown in this hall to our Society.

Mr. Washburn referred to his twofold party, and told us how it was a combination of scientific and sporting elements, and this may perhaps have reminded you of the many similar expeditions going each year from our own Universities not only to the Arctic, but to other parts as well. Their success both on this side and from America may be largely due to this similar feature, and the combination of the two elements appears to result in the one getting fresh vigour from the other, whether from rivalry, or from mutual encouragement; in any case it seems to make for success and markedly so in expeditions led and described so ably by our lecturer to-night.

The PRESIDENT: I find it extremely difficult to find words in which to express my extreme admiration of the magnificent slides and Mr. Bradford Washburn's most masterly lecture. I do not think we can possibly have seen anything more beautiful than the pictures which he put on the screen to-night. I ask you to express with me your very deep appreciation of his goodness in coming over here to give us this lecture. It is really an extraordinary treat that he has given us.

# SEISMIC SOUNDING ON SOUTH CRILLON AND KLOOCH GLACIERS: *A paper read at the Additional Afternoon Meeting of the Society on 6 February 1936, by*

RICHARD P. GOLDTHWAIT

*In conjunction with the preceding paper by H. Bradford Washburn, Jr.*

GEOPHYSICAL sounding on ice may soon reveal the mechanics of many glacial processes. In spite of the fact that seismic investigation is the best-suited geophysical method for this purpose, only four men have published seismic glacier surveys. From 1926 to 1929 Hans Mothes initiated and developed the idea with other German scientists on the Aletchgletscher and Hintereisferner of the Eastern Alps (Mothes 1926, 1927, and 1929). During 1929 the climax of interest in seismic surveying on ice inspired three separate investigations (Brockamp, 1930 and 1931, Kohler, 1929, and Sorge, 1930). Since that time the German Greenland Expedition (Brockamp, 1933), and the Second Byrd Antarctic Expedition (conversation with T. C. Poulter) have completed similar soundings on continental ice-sheets. The observations made by B. Brockamp with a seismograph recording three components of motion are undoubtedly the most advanced information. A few unsuccessful attempts to measure ice by seismic means emphasize the infancy of this new tool and its need for development. Since the early exploration of a new method in a new field often raises more questions than it answers, the data presented here offer at least five problems to each suggested explanation. However the mere unearthing of problems is an encouraging indication that seismic surveying may some day yield definite answers.

A geophysical party, consisting of one assistant and myself, gathered seismic field data on South Crillon and Klooch Glaciers of Alaska during the last week of June and the first two weeks of July 1934. The interest and help afforded by Mr. Bradford Washburn through the Base Camp of the Second Harvard–Dartmouth Expedition to Mount Crillon, and the willing assistance of all camp members, made this accomplishment possible. The expert advice of Professor R. A. Daly and Dr. L. D. Leet, of Harvard University, helped greatly in planning and interpreting this seismic survey.

The instrument used in Alaska was an electrical seismic prospecting outfit built by the Geophysical Research Corporation of New York and loaned to us by the Committee on Geophysics at Harvard University. Each geophone, or seismometer, consisted of a fine wire coil surrounded by bar magnets on flat springs to permit vertical motion. Any microscopic vibration of the magnets generated a tiny oscillating current which was magnified at least one hundred times by a radio amplifier. This amplification was based on two triode amplifier tubes (number 56) at 90 volts plate voltage and a special low-frequency output transformer. The magnified current oscillations moved a Westinghouse single element galvanometer. Two complete geophone-amplifier-galvanometer units were used simultaneously. These two galvanometers, and a third galvanometer which recorded the instant of a blast, were housed at one end of an upright brick-shaped oscillograph case. Light beams from a 6-volt bulb in the light-proof case reflected on the oscillating galvano-

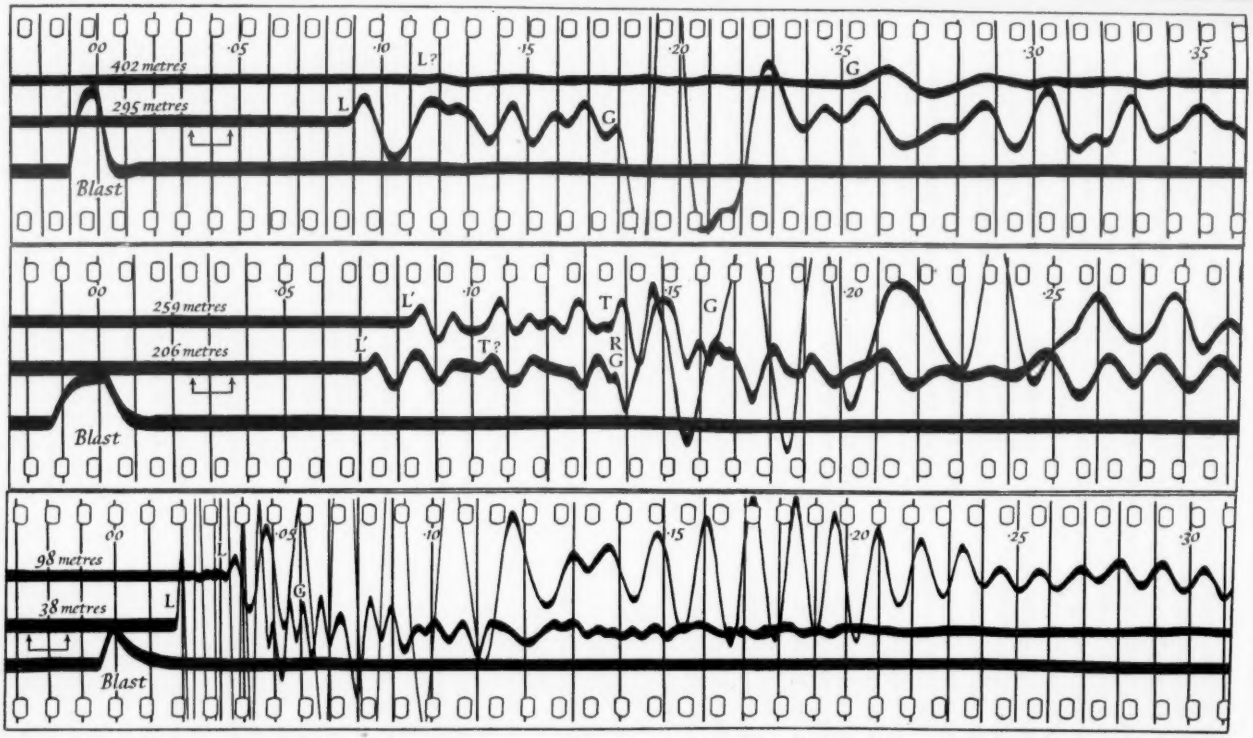



*Fig. 1. Sample Seismogram: The characteristic phases shown are the direct longitudinal wave (L), the refracted longitudinal wave (L'), the direct transverse wave (T), and the "ground wave" (G). The constant time correction is shown by a line segment near each blast*

meter mirrors and then through a cylindrical lens on to moving photographic tape. At every one-hundredth of a second sheets of light from another bulb passed between two overlapping fins on the prongs of a continually vibrating tuning-fork and made crosslines on the same photographic record.

This seismograph had many drawbacks as compared with the modern oil exploration equipment, as follows: its geophones were only moderately sensitive; the amplifier radio tubes deteriorated very rapidly (although they remained good enough for radio uses); the galvanometers leaked damping oil constantly and were extremely difficult to focus; each light source required 11 ampères of current, which is unreasonably great; photographic developing on ice is very slow and unpractical; and since the whole apparatus was designed originally for automobile use it weighed nearly 200 lb. (not including dynamite or cables). From the point of view of results it would have been highly desirable to record three components of motion, as was done with mechanical seismometers (Brockamp, 1933), but the added adaptability of this electrical outfit to very rough crevassed ice made it more suitable.

Artificial blasts created the necessary penetrating waves. We used 40 per cent. DuPont nitroglycerine dynamite supplied by a grant from the Milton Fund of Harvard University. No charge greater than five pounds was necessary, and the average was just less than one pound. All operations were carried on below the zone of permanent winter snow (on *Zungeneis*) where the melting ice surface is peppered with natural pipe-like water-holes ideal for blasting. Water provided tamping, but untamped charges in dry crevasses gave ample record traces over the short distances which glacier sounding permits. Not only was there lack of correlation between record amplitude and cover over the "shot," but there was only rough correlation between record amplitude and distance. Repeated charges of the same size at the same distance but in a different locality varied in trace amplitude by a factor of three. In general, blast energy was excessive within a few metres of the geophone, and dwindled rapidly as distance increased up to 100 metres. Records of these same blasts made several hundred metres away still showed measurable amplitude.

An electric circuit from the oscillograph set off the blast. Rubber-covered two-strand wire connected a 45-volt battery to ordinary electric-firing caps with long wire leads. The charge ignited unfailingly, even under water, and routine precautions prevented premature firing. This firing circuit was connected through resistances to the third oscillograph galvanometer, thus registering the instant of blast ("Blast" in Fig. 1).

The transportation of heavy equipment and small loads of dynamite over rough ice séracs dominated field procedure. The two geophones were placed in shallow water-holes or on firm erratic boulders about 30 metres either side of the oscillograph. The firing cable was laid in the direction of the line joining these geophones to blasts at successively greater distances. Thus all waves which were recorded travelled in approximately the same vertical plane. There was slight induction between the instrument cables for the two amplifier units. When the nearer geophone reacted violently to the first impulse this produced premature minor fluctuations in the record trace for the geophone farther away (see page 497, Fig. 1). Also minute currents of water over the

geophones produced confusing long-period oscillations in a few cases (see page 500, Fig. 4: beginning of 443 metre trace). Six to eight shots and records were made at distances up to 569 metres from the instrument location. This constituted an *initial seismic profile*. Then the seismograph was re-located at or near the most distant initial profile shot, and six or eight shots were repeated at similar distances from the geophones in the reverse direction back along the old line. This constituted a *reverse seismic profile*. Computation for the slope of any buried horizon requires these two sets of data (most seismic ice surveys have not taken this into account). Finally, we measured distances and relative elevations between all shot points with a stadia alidade mounted on a light photographic tripod.

We attempted three seismic profiles on each of two glaciers. Profile A was

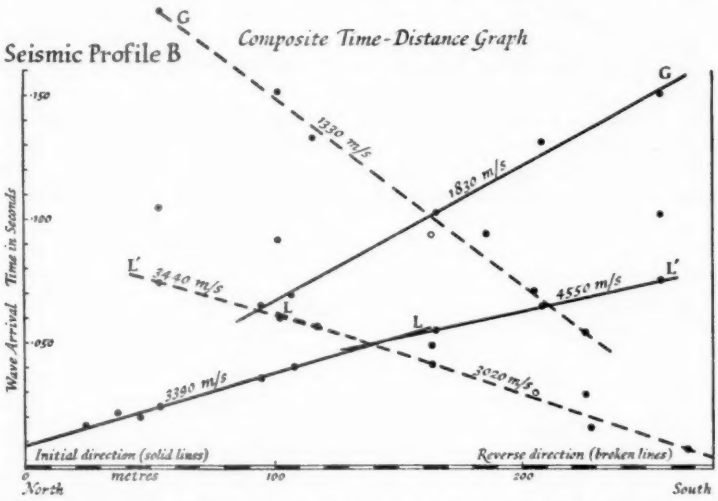



*Fig. 2. Seismic Profile across Klooch Glacier: Distance is plotted horizontally and time is plotted vertically. The apparent wave velocity, as indicated by the slope of each line, is given in metres per second. Solid points are well-defined phases on the record; hollow points are uncertain*

made at 410 to 770 feet elevation near the snout of Klooch Glacier and along its crowned central ridge parallel to ice motion (see Folding Map at the end of the *Journal*). Profile B was made at right angles to ice motion midway between an icefall and the snout of Klooch Glacier at 1050 feet elevation. Profile C, just below Klooch Icefall, failed entirely because amplifier tubes weakened and later the instruments were rolled into a crevasse by a loosened erratic boulder.[1] Profile F was located across South Crillon Glacier at 740 feet elevation half a mile north of the south terminus in Crillon Lake. Profile G was parallel to the valley wall and slightly west of the glacier centre 1 mile

[1] Profiles D and E were made on glacial gravels and are not reported in this account of glaciers.

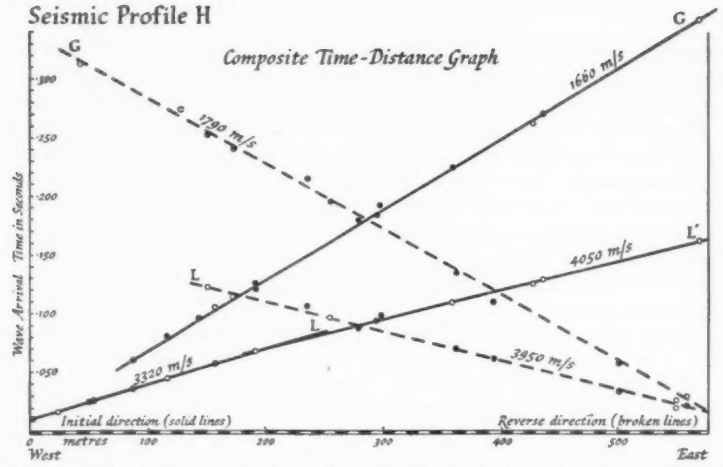



*Fig. 3. Seismic Profile H along South Crillon Glacier: Distance is plotted horizontally and time is plotted vertically. The apparent wave velocity, as indicated by the slope of each line, is given in metres per second. Solid points are well-defined phases on the record; hollow points are uncertain*

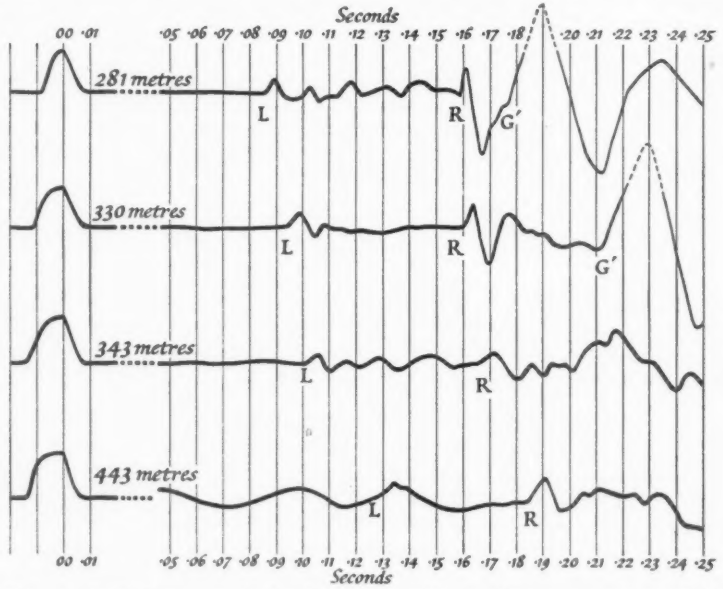



*Fig. 4. Reflection records for Seismic Profile G: The traces are carefully enlarged and copied from original records, and "time corrections are eliminated" in the process. Reflection phases are marked R. Some of the maximum amplitude oscillations (G) ran off the records, and so these are shown as broken line*

above the terminus. It ran from 1050 to 1210 feet elevation almost on the ice divide where South Crillon Glacier splits toward Crillon Lake on the south and toward Lituya Bay on the north. And finally, Profile H was completed at 1490 to 1600 feet elevation parallel to ice motion and on the centre of South Crillon Glacier more than 2 miles from the Crillon Lake terminus. Reverse profiles were successfully completed at Profile locations B, F, and H. We numbered shots consecutively throughout the summer.

Each record consists of four elements. Thin time lines cross the record every one-hundredth of a second. These vary in linear spacing on the record because the camera sprocket wheels carrying the photographic tape were hand driven (see record at the bottom of Fig. 1). Accurate interpolation to one-thousandth of a second is possible. Three galvanometer traces run the length of each record. A sharp break in the lowest trace registers, first, the instant when the switch was thrown, and then the instant when the circuit broke and the blast occurred. The two upper lines show the subsequent reactions of the two geophone seismometers. Due to systematic plug-in instrument connections each "up-trace" on these records indicates an up-motion of the ice, and vice versa.

Interpretation depends upon sudden changes in the character of a trace. The commencement of a large amplitude swing, or of some new period interval between swings, is a guide to the arrival of waves travelling different paths at different velocities. The reality of such a "phase" is contingent upon its presence in several records of one profile, and its meaning is contingent upon the arrangement of points marking wave arrival time on a time-distance graph. The slope of a line through any set of time-distance points is directly related to the velocity of this wave type because it measures the increase of travel-time with distance. Unfortunately, two time corrections enter into each reading: one for the separation between the instant of blast and the line arbitrarily selected as "zero time," and one, a constant correction, due to the fact that the light for the time lines entered the cylindrical lens to the record at an angle different from the light reflected from galvanometer mirrors.

In most records the "first impulse" of the trace is most easily and accurately measured (see phase L, Fig. 1). It is universally true, where three directions or components of ground motion have been measured, that this fastest travelling wave type involves compressional particle motion which is longitudinal and parallel to the direction of wave propagation (designated L on these records and graphs). Since all of these traces began as an "up" motion the first motion of the ice was a compression. Ten to fourteen good travel-time readings for each profile determine straight-line segments on the time-distance graph (see Figs. 2 and 3). This indicates constant velocity through the ice for several tens of metres depth (changing velocity is indicated by a curved direct wave line).

In three initial profiles and two reverse, the first line segment near the origin is broken by a flatter, and therefore higher velocity line segment (L′) based on the time of the first impulse in traces generally 200 metres and more from a blast. This indicates ice at a depth which refracts waves received from the overlying ice, and transmits them at sufficiently greater velocity to actually

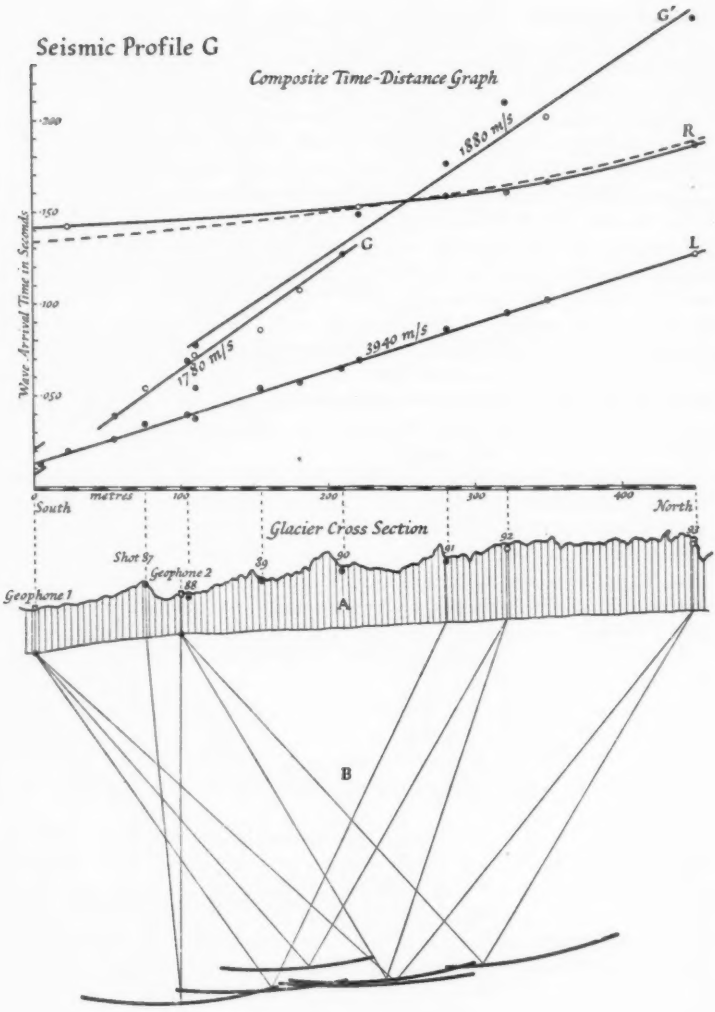



*Fig. 5. Seismic Profile G along Crillon Glacier: The solid points represent clear-cut phases, the hollow points uncertain phases. A is the zone of crevassed ice, determined at the south end by points computed from travel-time, and at the north by observed increase in surface crevassing. B is massive ice. The glacier bottom is determined by reflections (Fig. 4) which follow paths suggested by the fine oblique lines*

overtake and precede the direct wave in reaching distant seismometer locations.

The time-distance line representing the direct longitudinal wave arrival (L) does not project downward to the origin at zero time zero distance. Yet obviously at the blast the impulse started at zero time. Our experiments on other solids, and those by other investigators, eliminate the possibility that there is any time lag greater than one-thousandth of a second between the fusing of the wire in the dynamite cap and the actual discharge of energy. Still more unusual is the absence of a steep low-velocity line from the true origin to explain this offset. Ordinarily it indicates loose unconsolidated surface material. Even when our geophone was 2 to 5 metres away from a quarter-pound charge the impulse took eleven to seventeen-thousandths of a second to arrive.

Apparently the only answer to fit all these facts is interruption by crevasses. Parting or some allied vertical planes must have separated the geophone from the shot, although open crevasses were observed in only two of four cases of close shots. It is possible that this theory may be supplanted some day by theories of wave mechanics since the average depth of these crevasses is 20 metres and the average wave length of the longitudinal wave from short distances is also 20 metres. However, the fluctuations of time offset do not correlate with those of wave length on different seismic profiles. Since the waves travelled down and back around crevasses, the product of one-half of the time offset and the true velocity of upper ice (see Table 5[1]) gives a very close measure of the depth of crevassing (Table 2). Inasmuch as solid ice is traversed around these crevasses the velocity is probably like that of the solid ice beneath, but not much less, as is the case on the Greenland snow surface (Brockamp, 1933). The depth figures for crevasses are probably correct to the limit of accuracy of record reading, *i.e.* one-thousandth of a second, which represents less than 2 metres of depth.

A phase clearly defined by large amplitude, long period, and late arrival (G) adds to our information about crevassing. This represents the slowest travelling wave motion common in all records. At short distances it commences with a definite down motion of the ice and the oscillations last several hundredths of a second, while at long distances the initial down-motion is sometimes entirely absent and broad swings stop abruptly after one or two oscillations. In Profile G a line (G′) plotted for the beginning of the up-motion which succeeds the usual down-motion converges toward the normal G line projected to long distances. Furthermore when the normal G line is projected downward toward the origin it intersects the time ordinate at approximately the same point as the longitudinal direct wave line (L). The inference is that this slow wave (G) travels to the bottom of the crevassed zone as a longitudinal wave, or more properly, the effective source of the impulse for all waves is a disturbed centre at the bottom of the crevassed ice directly below the shot. Since the slow phase was not often recorded within 50 metres of a shot the time offsets are not nearly so exact as those for longitudinal wave lines, but they do check estimates based on longitudinal waves (Table 2).

The apparent variation of the velocity of clearly defined direct longitudinal

[1] The tables are printed at the end of the paper.

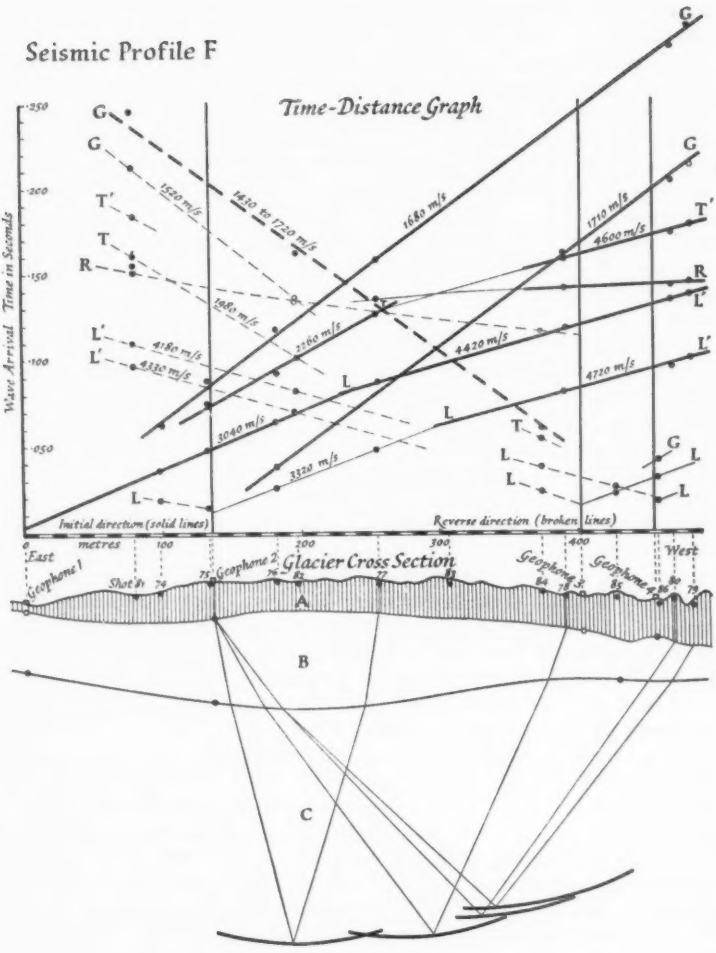



*Fig. 6. Seismic Profile F across Crillon Glacier: The solid points represent clear-cut phases. The heavy lines are well determined and the thin lines are suggestive only. This time-distance graph is actual, not composite. A is the zone of crevassed ice; B is the upper, or low velocity, massive ice; C is the lower, or high velocity, massive ice. The thin oblique lines suggest the paths followed by reflections from the bottom. Reflection depths for the reverse profile are omitted to avoid confusion*

waves from 3020 to 4110 metres per second is a unique problem. Ordinarily the direct wave velocity throughout any one medium is nearly constant. It is significant here that the average of the direct wave low velocity value with the direct wave high velocity value in each profile showing a broken lower line on the graph (Profiles B and F, Table 1) is almost identical with the single line high velocity of Profile G. On Profile H the line is clearly broken in the initial direction and unbroken in the reverse direction. If any one doubts the reality of these data, let him observe the agreement of total travel-time over similar paths in any initial and reverse profile.[1]

Regularly increasing or decreasing depth of crevassing may explain the apparent velocity variations. In Initial Profile H the shallow crevassing shown by a small time ordinate offset is accompanied by low direct wave velocity, whereas the graph for Reverse Profile H shows deep crevassing and thus delayed wave arrivals. Similarly the unbroken longitudinal wave lines of Profile G are associated with deep crevassing. This indication of changing depth of crevasses was used as supplementary information to fixed depths determined below each geophone location (Table 2) for the placing of the lower limit of crevasses between geophone locations on Glacier Cross Sections (Figs. 5 and 6). The known increase of crevassing in Profile H is hardly sufficient to account for an apparent velocity increase to make the direct wave line merge with the refracted wave line; nevertheless this may be partial explanation of that fact.

What is the depth of the high velocity refracting ice? Certainly the average apparent velocities for the direct wave in any one profile will be very nearly a true value. With the added information of two apparent velocities for waves in the deeper ice and the position of the intersection of direct and refracted wave lines, the depth and slope of the horizon dividing these two layers can be calculated from trigonometric relations.[2] A change of 100 metres per second in any wave velocity changes the results by 5 per cent. This is probably the limit of error.

Initial Profile F is not treated as a composite time-distance graph, for an attempt to do so showed distinct sets of longitudinal wave lines and points for each geophone. Different offsets on the time ordinate indicate different depths of crevassing under each geophone, and different intersection locations of the direct (L) and refracted (L′) wave lines indicate different depths to the high velocity ice horizon (double values are given for Initial Profile F in Tables 2 and 5). Splitting the diagram into four graphs reduces the number of points determining some lines to two or three points in uncertain agreement, so these are shown as thin lines (Fig. 6).

In Profiles B, G, and H some one stadia measurement of distance from the shot to the geophone was found to be obviously in error. The records of these shots were not discarded since a slight shift of the wave arrival points on the time-distance graph along the distance ordinate brought the points into

[1] A slight correction for any small differences in the measured distances between the shot and geophone in the two cases must be added, but these are of the order of two-thousandths of a second.

[2] Full discussion in "Theorie der 3-Schichten-Seismik," by Oswald v. Schmidt, in *Zeitschrift für Geophysik*, J. 7, H. 1 (1931), 37 to 56.

perfect agreement with well-determined velocity lines. Moreover, since error of distance measurement affected both traces of one record, both sets of readings were shifted by the same amount to bring about agreement.

During sounding operations a sharp phase, intermediate between longitudinal and slowest wave phases, appeared to be a third type of wave motion. Subsequent plotting placed these arrival-time points in an extremely high velocity line which is concave upwards (R on Time Distance Graph, Fig. 5). This is a typical reflection curve. Traces recording this phase are from shots 200 to 400 metres away (0·6 to 1·4 times the calculated depth to the reflecting layer). The waves had a period of six to eighteen-thousandths of a second and the initial motion was always upward, just as in the case of direct longitudinal waves (Fig. 4). It is startling to find reflected wave oscillations of greater amplitude than direct wave oscillations. Mothes believed that the similar effect which he found in the Alps was due to the fact that reflected energy arrives from below and has a strong vertical component, while direct wave energy arrives from the side and has little effect on a vertical instrument.

Reflected wave travel-times are far too great to indicate reflections from the high velocity ice horizon, and since that horizon did not send back other discernible reflections it is highly unlikely that there is a still deeper layer representing sufficient velocity difference to be responsible for these reflections. Since 4000 metres per second was the maximum velocity in deep Greenland ice (Brockamp, 1933) it is unlikely that there is ice with velocity much in excess of that in Alaska. Furthermore the calculated reflection depths agree nicely with depths expected from the geological considerations. Thus these are probably reflections from hard rock or debris under the glacier.[1]

I used each reflection wave arrival-time to calculate a depth. In Profile G the travel-time involved in circumnavigating the vertical crevasses at each end of the path was subtracted, and then the remaining distance (travelled at average velocity, Table 1) was plotted from the focal points directly below the shot and the geophone, at the bottom of the crevassed zone. The locus of points satisfying a fixed travel-time distance is an ellipse about these foci. Sections of these ellipses limit the position of rock bottom (Glacier Cross Section, Fig. 5). From known right triangle relation [2] these depths below the crevassed zone are 240, 227, 240, 250, 240, and 233 metres. The total average thickness of the ice is about 270 metres.

Profile F is the only other location at which we received reflections. Four traces on the initial profile and four on the reverse profile resemble the reflection phases of Profile G (Fig. 4). The difficulties of figuring depth are increased by the known velocity layering. Assuming that the wave path was vertical through the crevassed zone, and that it travelled an angular path in the upper ice approximately determined by refraction at the horizon between the ice layers, the travel-time for the waves in upper ice was subtracted and the elliptical loci of points satisfying the remaining travel-time were plotted as

[1] The rock beneath the glacier is for the most part highly metamorphosed schist, but there may be slightly metamorphosed volcanic rocks under Profile G and part of F since the glacier distributaries all follow a north-west to south-east fault-line in this region.

[2] The formula for depth ($z$) where the total distance between focal points ($d$), the true velocity of the waves ($v$), and the travel-time ($t$) are known is: $t=((4z^2+d^2)/v^2)^{\frac{1}{2}}$.

before. The measurements on Initial Profile F agree well at an average total depth of 250 metres (Glacier Cross Section, Fig. 6). However the Reverse Profile depths showed the same slope of the bottom just 20 metres deeper.

Each layer penetrated involved added uncertainties and accumulated errors. It is no wonder that computations to rock bottom cannot be stated with precision. In the first place we do not know how much the third dimension influences the disagreements in the computations. Neither Profile F nor Profile G were made close enough to the edge of South Crillon Glacier to record confusing lateral reflections from the sidewalls. In the second place there were no direct data for velocity layering at Profile G, and so computations are based on the single high velocity value which might give results up to 20 metres too deep. Also, a slight variation in the depth of the zone of crevassing influences the depth of slow velocity ice to be penetrated. Finally the depth of penetration of refracted waves to a deeper horizon is limited by the length of wire available between the blasts and the geophones. The depth of penetration to a horizon separating velocity differences similar to those found is only about 100 metres. However the existence of ice of such a very high velocity is unlikely. Cut-and-try variations based on all these uncertainties indicate a maximum error of 20 per cent., and the results are probably correct to within 10 per cent.

Seismic records in nearly every survey indicate two types of waves: the longitudinal wave and a slower transverse wave involving particle motion at right angles to the direction of wave propagation. All of my contemporaries in ice surveying have selected the low velocity big amplitude phase (G) as this transverse wave. On this assumption my velocity determinations agree well with theirs (Table 6). However I suggest that this large-amplitude wave phase may be the "ground wave" or Rayleigh wave found in all seismic surveys on rock. If the direct longitudinal wave impulse makes a slight trace amplitude in contrast to the reflected wave trace because the energy arrives from the side rather than from below, why does a transverse wave arriving from the side make a trace up to six times as large as either direct or reflected longitudinal wave? Ground waves in bed rock involve rotational ground motion with the largest amplitude on the record. For this reason, and because of the long period of the oscillations, I have labelled those wave phases and lines "G" for ground wave.

I have interpreted a smaller and less common phase intermediate between the direct longitudinal and ground waves as a transverse impulse on records of Profile F (phase T, 259 m. trace, Fig. 1). Other profiles suggest spasmodic single points or pairs of points marking transverse wave arrival. These waves show velocities of 2310 and 2170 metres per second on Profile F which has the only reliable series of points. Taking the average, which is probably nearly correct for transverse wave velocity, the value for Poisson's ratio is 0·12. This is ridiculously low, but it must be borne in mind that seismic determinations of physical constants in any material composed of separate grains (like gravel or granular ice) are unreasonable since the well-established formulas for homogeneous solids do not apply.

There are no other phase occurrences recognized frequently enough to determine good velocity lines. A poor suggestion of refracted transverse

waves is seen in Initial Profile F (T′). At short distances the slow-moving air wave from the blast is recorded. Also, a set of smooth oscillations of regularly growing and diminishing amplitude sometimes appears after ground waves at short distances (Fig. 1). These phases may be explained some day by further knowledge of the mechanics of wave propagation.

In summary we may draw a rough three-dimensional picture of the lower half of South Crillon Glacier. The surface ice acts seismically as though crevassed to several metres depth even under smooth surfaces. Where the ice surface is obviously rough and crevassed this effect is found to 30 metres depth. Below the crevassed zone the essentially solid homogeneous ice is divided into two velocity zones: (1) about 60 metres of ice which transmits longitudinal waves at 3200 to 3600 metres per second, and (2) thick lower ice which transmits longitudinal waves at about 4000 metres per second. The horizon between these two layers seems to parallel the concave rock floor beneath the centre of the glacier (Fig. 6). It is possible that this coincides with the U-shaped horizon under the superimposed ice of the tributary glacier (discussed under "Complex Morainic Bandings," pp. 485 *sqq.* and diagram, p. 489). However the same layering effect is found on Klooch Glacier (Profile B) where there is no superimposed glacier.

In general the regular U-valley rock floor seen at the Crillon Lake terminus of South Crillon Glacier is continued under the glacier. At Initial Profile F, just below a right-angle bend and steep slope of Crillon Glacier, reflection soundings show that the rock floor is gouged and over-deepened 50 metres below the level of the valley floor at the ice terminus in Crillon Lake, and therefore below sea-level. Exactly similar over-deepening to 90 metres below sea-level was found in the old vacated lower Crillon Lake valley by water soundings with a line. Furthermore seismic soundings at Profile G on the outside of the same right-angle bend in South Crillon Glacier indicates that even under the ice divide between Crillon Lake and Lituya Bay the glacier bottom is about at lake-level. If Crillon Glacier were removed Crillon Lake would probably overflow into Lituya Bay.

*Table 1.—Longitudinal Waves*

| *Profile.* | *Traces.* | *Distances.* | *Periods.* | *Velocity.* |
|---|---|---|---|---|
| | *Direct waves showing low velocity*, L | | | |
| B initial .. .. | 8 | 16 to 138 m. | 0·008 to 0·011 s. | 3390 m/s |
| reverse .. .. | 7 | 10 161 | 0·008 0·013 | 3020 |
| F initial .. .. | 7 | 8 183 | 0·005 0·011 | 3180 |
| reverse .. .. | 7 | 3 82 | 0·006 0·010 | (3830) |
| H initial .. .. | 9 | 2 192 | 0·006 0·014 | 3320 |
| *Average* .. | *8* | *up to 180 m.* | *0·007 0·012* | *3230* |
| | *Direct or refracted waves showing high velocity*, L | | | |
| A initial .. .. | 10 | 4 to 390 | 0·005 to 0·010 | 4110 |
| G initial .. .. | 14 | 5 450 | 0·005 0·009 | 3940 |
| H reverse .. .. | 10 | 18 425 | 0·006 0·018 | 3950 |
| *Average* .. | *11* | *all distances* | *0·005 0·012* | *4000* |
| | *Refracted high velocity waves*, L | | | |
| B initial .. .. | 4 | 138 to 256 | 0·009 to 0·013 | 4550 |
| reverse .. .. | 3 | 161 223 | 0·010 0·014 | (3440) |
| F initial .. .. | 7 | 256 482 | 0·008 0·014 | 4570 |
| reverse .. .. | 4 | 206 376 | 0·010 — | 4260 |
| H initial .. .. | 6 | 296 569 | 0·011 0·019 | 4050 |
| *Average* .. | *5* | *beyond 200* | *0·010 0·014* | *4360* |

Parentheses () indicate poor agreement of points and uncertain determinations.

*Table 2.—Depth of Crevassing*

| *Profile.* | *From direct longitudinal waves.* | *From "G" waves.* | |
|---|---|---|---|
| A initial .. | 31 metres | 33 metres | Hummocks |
| B initial .. | 13 | (21) | Low ridges |
| reverse .. | 6 | — | Low ridges |
| F initial: G–1 | 7 | — | Smooth |
| G–2 | 22 | — | Hummocks |
| reverse .. | 25 | (17) | Hummocks |
| G initial .. | (26) | (18) | High hummocks |
| H initial .. | 20 | 16 | Low ridges |
| reverse .. | 29 | 29 | High hummocks |

Parentheses () indicate uncertain data.

*Table 3.—Slow Waves G*

| *Profile.* | *Traces.* | *Distances.* | *Periods.* | *Velocity.* |
|---|---|---|---|---|
| A initial .. .. | 5 | 101 to 393 m. | 0·012 to 0·025 s. | 1870 m/s |
| B initial .. .. | 5 | 95 265 | 0·012 0·040 | 1830 |
| reverse .. .. | 6 | 51 223 | 0·015 0·030 | 1330 |
| F initial .. .. | 10 | 47 482 | 0·009 0·050 | 1690 |
| reverse .. .. | 6 | 55 376 | 0·011 0·040 | 1550 |
| G initial .. .. | 12 | 55 443 | 0·020 0·040 | 1830 |
| H initial .. .. | 12 | 88 569 | 0·015 0·035 | 1660 |
| reverse .. .. | 12 | 18 532 | 0·007 0·020 | 1790 |
| *Average* .. | *9* | *beyond 50* | *0·013 0·035* | *1690* |

See discussion of wave type and ground motion on p. 507.

*Table 4.—Comparison of Initial and Reverse Times over Similar Paths*

| | | | |
|---|---|---|---|
| | *at 165 m.* | *at 138 m.* | |
| B initial .. .. | 0·055 s. | 0·049 s. | |
| reverse .. .. | 0·058 | 0·049 | |
| | *at 259 m.* | *at 334 m.* | *at 390 m.* |
| F initial .. .. | 0·082 s. | 0·097 s. | 0·117 s. |
| reverse .. .. | 0·082 | 0·099 | 0·113 |
| | *at 359 m.* | *at 428 m.* | |
| H initial .. .. | 0·110 s | 0·126 s. | |
| reverse .. .. | 0·112 | 0·124 | |

*Table 5.—Depths to High Velocity Ice*

| | *Approximate* true *wave velocities:* | | *Depth of horizon:* | | *Slope of horizon:* | |
|---|---|---|---|---|---|---|
| *Location.* | *Direct.* | *Refracted.* | *Below crevasses.* | *Below ice surface.* | *To ice surface.* | *To horizontal.* |
| B initial .. | 3200 m/s | 4000 m/s | 40 m. | 53 m. | 11 N. | 11 N. |
| reverse .. | 3200 | 4000 | 11 | 17 | 11 N. | 11 N. |
| F initial .. | 3400 | 4450 | 43 | 50 | (1·3 E.) | (1·3 E.) |
| and .. | 3400 | 4450 | 66 | 88 | (3·4 E.) | (3·4 E.) |
| reverse .. | 3400 | 4450 | 35 | 60 | 3·4 E. | 3·4 E. |
| H initial .. | 3600 | 4000 | 26 | 46 | 1·6 W. | 0·1 E. |

All slopes are *average* slopes of the line through determined points under the geophone and the blast. Those in parentheses () are known to misrepresent local changes in slope.

*Table 6.—Results of Seismic Ice Surveys*

| *Year of work.* | *Author.* | *Glacier.* | *Velocity of Long. waves.* | *"G" phase* | *VL/VG* |
|---|---|---|---|---|---|
| 1926 | Mothes | Hintereis | 3400 | 1600 | 0·47 |
| 1928 | Mothes | Hintereis | 3600 | 1690 | 0·47 |
| | | | 3140 [1] | 1350 | 0·43 |
| 1929 | Mothes | Aletch | 3570 | 1670 | 0·47 |
| 1929 | Mothes-Brockamp | Pasterz | 3580 | 1670 | 0·46 |
| 1929 | Kohler | See-Eis | 3200 | 1700 | 0·53 |
| 1929 | Sorge | Greenland | 3470 [1] | 1700 | 0·49 |
| 1934 | Goldthwait | Crillon | 3400 [1] | 1690 | 0·50 |

[1] Observations made on snow surface (Firneis).

*Editorial Note.*—It is not quite clear from Mr. Goldthwait's notes which of the results expressed in Table 1 have been used to obtain the velocity of 3400 m/sec. in Table 6. Dr. Brockamp (*Wissenschaftliche Ergebnisse der Deutschen Grönland-Expedition*, Band III, p. 42, 1935) gives the following as reliable values for the longitudinal speeds: from the Alps 3600 m/sec., from "Winterhaus" at the edge of the Greenland ice-cap 3720 m/sec. and at 60 and 120 km. distance from the coast 4000 m/sec. The corresponding "G" speeds are 1680, 1750 and 1850 m/sec. Reference to a previous publication by the same author (*ibid.*, Band II, 1933) shows that his curves were interpreted to indicate layers of differing speeds. Thus at 62 km. there was at between 80 and 200 m. depth a layer with 3600 m/sec. and from 1300–1972 m. a layer with 4000 m/sec.; and at 120 km. from 150 to 500 m. depths there were speeds of 3600–3700 m/sec. and from 1230–2100 m. 4000 m/sec. Mr. Goldthwait's high-velocity ice at very moderate depths is therefore a newly observed phenomenon.

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## DISCUSSION

Before the paper the PRESIDENT (Major-General Sir PERCY COX) said: I hope that many, if not most of you, were present on Monday night when Mr. Bradford Washburn read his most interesting paper. I told you then that he and Mr. Richard Goldthwait, who is to address us this afternoon, had just come to England for a few days from America to give us these two lectures.

Mr. Bradford Washburn is Instructor in Geographical Exploration at Harvard, and Mr. Goldthwait is a geologist by profession. Both were on the Harvard–Dartmouth Alaskan Expedition to the mountains of Alaska and the conquest of Mount Crillon. It was on that subject that Mr. Washburn showed some perfectly beautiful slides and a film of wonderful ski-ing on the slopes of Mount Crillon. Mr. Goldthwait is now going to deal with the subject of seismic ice-survey of the Crillon Glacier. The non-experts like myself among you at any rate know that the movement of glaciers in one manner or another is a subject of the greatest interest and intricacy. I will now call upon Mr. Goldthwait to deliver his lecture.

*Mr. Goldthwait then delivered the lecture printed above, and a discussion followed.*

Dr. H. SHAW (Science Museum): I should like to express my appreciation of Mr. Goldthwait's excellent lecture and the remarkable lantern slides that he has shown to us; also to congratulate him on the results which he has obtained.

Some time ago I was privileged to conduct a certain amount of seismic exploration work, and fortunately for me the work was done in this country and under the very best weather conditions. Still I had an opportunity then of discovering the sort of difficulties that are encountered when doing seismic work in the field, and I have nothing but admiration for any one who had the courage to tackle such work on a glacier.

There are one or two points of particular interest to me which have occurred in the paper, and I should like to take up a moment or two of your time in mentioning them.

First of all, it seems remarkable that the seismic method should be able to reveal two distinct layers in a glacier such as we have seen on the screen, layers which are not just slightly different from each other but layers in which the velocity of the compression waves is very pronouncedly different. There appears to be no doubt about this point, and it will be of interest to see whether the explanation put forward by Mr. Goldthwait can be subsequently confirmed by any other means.

Mr. Goldthwait pointed out that his time-distance curves did not pass through the origin in any particular case. Similar results are usually obtained in seismic prospecting. The time-distance curve never passes actually through the origin. This phenomenon is generally ascribed to weathering of the surface-layer, and it is particularly interesting in this case to notice that the phenomenon is attributed to the fissuring or crevassing of the glacier. The degree of crevassing, by which I think is meant the depth of the crevasses, is found to be related to the time lag of the waves through the ice.

Results of a similar nature have been obtained in the north of England, not on glaciers but in attempts to ascertain the topography of subdrift limestone below the surface layers of the ground. There it was found that if large potholes occur in the surface of the limestone, results similar to those described (that is delay of the pressure wave in its travel) were obtained, which were definitely attributable to the presence of these large concavities in the surface of the limestone.

As one who is interested perhaps more particularly in the instrumental side, there are one or two points I should like Mr. Goldthwait to have mentioned, but which unfortunately he omitted. One would like, if possible, to have a little more information concerning the natural period of the instrument and whether it was actually buried in the ice or just lowered down a crevasse. And was the same charge employed all the time? If a reasonably large charge was employed, what steps were taken to protect the instrument when located at a distance of 2 metres from the explosion ?

Lastly, I would like to ask Mr. Goldthwait if he could tell us what was the velocity of the waves through the ground underneath the glacier.

Mr. RICHARD GOLDTHWAIT: I am sorry I did not have more time to go into detail about the seismograph used. The natural period of the seismometers was about eight-hundredths of a second. These seismometers (which I called geophones) were placed just as the blasts were placed, in natural water-holes in the ice. Occasionally they were located on glacial erratic boulders. To protect the instrument from nearby shots we merely made sure that the blasts were very small and that they were hidden behind a sérac from the instrument itself.

I did not determine the velocity of waves in the rock beneath the glacier in any of the profiles which I have shown on the screen, because the distance between the geophones and the blasts was not sufficient to permit reception and registration of refracted waves from that depth. That was unfortunate in a way, but we did not have enough cable. However I did determine the velocity in the bedrock near the terminus of the glacier in land Profiles D and E. If we assume that the rock beneath the glacier is the same as that at the end, its velocity is about 5500 metres per second (the velocity in the lowest ice layer was of the order of 4000 metres per second, as you may remember).

The PRESIDENT: Dr. Loewe was on the Wegener Expedition to the Greenland

Ice-Cap and is now at work at the Scott Polar Research Institute at Cambridge. We hope he will say a few words.

Dr. FRITZ LOEWE: As one who knows how difficult seismic measurements on glaciers really are, I have very good reason to congratulate Mr. Goldthwait upon his results.

A point that seems to me interesting is that on the German Greenland Expedition Alfred Wegener made our measurements with quite different instruments, not with an electrically recording seismograph, and it is interesting to note that, on general lines, the results obtained with the instrument Mr. Goldthwait used are much the same as we obtained. But they are identical only on general lines; in some special questions the results are rather different.

First, in Greenland also different velocities of the longitudinal wave in ice have been found, but it is interesting to note that they have only been observed in the interior of the ice-cap and not on alpine glaciers or on glaciers in Greenland under conditions similar to those under which Goldthwait measured. So we are astonished to see on this relatively shallow and warm Crillon Glacier such high velocities as 4000 metres a second and the distinct layers which are known only in the interior of Greenland.

As to the influence of crevasses; if I understood aright, Mr. Goldthwait said that they made some explosions at very slight distance and that also those explosions gave a line that did not go to the zero point. If he made an explosion at 5 metres distance and had his crevasse between his seismograph and the point of the explosion, then I could accept his explanation, but if not, I am not quite certain whether his explanation is a true one.

With regard to the reflected waves, which question has probably been examined by Mr. Goldthwait, I would like to ask: had your reflected wave the same period as the direct longitudinal waves, and have you any other explanation than the shearing to account for the high-velocity ice?

And then concerning the question whether the waves of about half the velocity of the longitudinal waves are transverse or Rayleigh waves. As far as I remember, the period of the Rayleigh wave is not necessarily the same but the first period is longer than the following ones. If it is a transverse wave the period is nearly the same throughout. What was it in your case? On glaciers of alpine type one has not been able to make out the Rayleigh waves from the transverse waves. In the interior of Greenland two different waves were found. The first wave, the transverse wave, showed all the qualities it should, and for the slower waves different qualities of Rayleigh waves could be found. The relation of velocity between the Rayleigh waves and the transverse waves was as it should be, namely, about 0·92. I would ask from which qualities on his records Mr. Goldthwait can see that it is a Rayleigh wave and not a transverse wave.

There is another question which is not concerned with the seismic measurement but with the measurements of glacier movement. Were you certain that your instrument was not tilted by melting effects and that part of the "pulse flow" of the ice was not due to an inclination of the instrument?

In conclusion, I should like to congratulate Mr. Goldthwait once more on his results which are the first on an extra-European valley glacier, apart from some measurements in Greenland, and which point to an unexpected variety of qualities in glacier ice. I hope the seismic method will be applied to a greater extent in the study of glaciers in varying climates and by telling us something about the thickness and the differences of elasticity of glacier ice will contribute to a better understanding of glacier types and glacier motion.

Mr. RICHARD GOLDTHWAIT: There were four instances in which the blast

was within 5 metres of a geophone. In two cases there were open crevasses which we observed. Although we could not see a crevasse in the other two instances I think the evidence is strongly in favour of crevassing as an explanation for the time-ordinate offset.

The reflected wave period was exactly the same as that of the longitudinal wave. It has greater amplitude, that is, it gave a greater kick to the instrument, than the direct wave, because, as Dr. Brockamp has pointed out, it arrives obliquely from the bottom of the glacier whereas a direct wave arrives horizontally and cannot have so much effect on a vertical instrument.

I desired merely to suggest that the velocity layering may be correlated with fracture phenomena which are restricted to upper ice as seen in the vertical ice front. The only other observation which I can make with regard to different velocities of wave transmission at different depths is that it might be a characteristic result of unknown temperature changes.

In regard to the wave which I called "G," I should emphasize that it does have the characteristics of a Rayleigh wave. The period of the first swing was of the order of 10 to 20 thousandths of a second, and later oscillations increased in period up to 40 or 50 thousandths of a second.

The possibility of latitudinal motion of the marker at which we aimed a theodolite to watch glacier motion is a valid question. Undoubtedly that was one of our greatest problems. Mr. Washburn painted the box which held the motion marker dense black so that it would sit firmly and melt in as fast as the ice melted down. Furthermore, I checked the angle between several motion markers in 1933 from the station at the edge of the glacier to see that the markers held the same relative position to each other. This was not done when the 1934 motion graphs (shown) were made.

The PRESIDENT: Dr. Bullard, will you add a few words? Dr. Bullard is a member of the Department of Geodesy and Geophysics at Cambridge.

Dr. E. C. BULLARD: Mr. Goldthwait has raised a number of points of very great interest. First, a technical one. In building these instruments one of the principal troubles is the design of an oscillograph which is sufficiently sensitive and at the same time sufficiently robust and sufficiently insensitive to temperature variations to work under field conditions. Could Mr. Goldthwait tell us what type of oscillograph was used in these measurements?

Secondly, as to the delay in starting and its connection with crevassing: is it absolutely certain that the delay was real? I have often wondered whether the charge really goes off within a few thousandths of a second of the fusing of the detonator wire. There are several steps between the fusing of the wire and the explosion of the charge; is it certain they happen sufficiently quickly? I do not know whether there is any evidence on that question, but it would be quite easy to get it.

It struck me that the period of the Rayleigh waves was shorter than those usually found in rock. Perhaps Mr. Goldthwait can tell us whether they are always shorter in ice and, if so, why.

He has, he said, found that the valley of the glacier is gouged out. There has been a great deal of argument in the past as to the structure of fjords, particularly as to the origin of the deepening which occurs as one goes up the fjord. It has been suggested that it is impossible this should have been done by ice. I should like to ask whether the gouging out of this glacier is of the same order of magnitude as the deepening found in the Norwegian fjords, and whether it has any bearing on the question of the origin of fjords.

Mr. RICHARD GOLDTHWAIT: Since I will not have time to say much more about the oscillograph I should like to have a chat with Dr. Bullard afterwards.

It was not a modern oscillograph; it was built in 1927 I believe. The whole oscillograph was about 2½ feet long, 1 foot high, and 5 inches wide.

The first explanation I had for the time offset which I have attributed now to crevassing, was, as Dr. Bullard suggests, delayed firing of the dynamite. In Profiles D and E (not described here) I made blasts on solid land near the geophone, and so far as I could tell the impulse was coincident with recorded cap-wire fusion. The velocity lines on these graphs intersect at zero, with however a slight curve at the initial end due to the so-called "weathering zone" which is found in most seismic prospecting.

The Rayleigh wave, as I understand it, generally has a much longer period than five-hundredths of a second, but very little is known about the Rayleigh wave at ranges within a mile or two of a disturbance. Since the greatest distance over which we made any of these experiments was only 600 metres, and it is known that the Rayleigh wave has a decreasing period with shorter distances, I think it should probably have a relatively short period here.

The over-deepening which I have indicated on the profile is exactly comparable to the over-deepening in the fjords of British Columbia. Numerous scientists in that region have found that there are great hollows in the fiord floors, and there are bars or underwater reefs near the fjord mouths. We found an over-deepening in Crillon Lake to 400 or 500 feet which is not uncommon in British Columbia. I believe the same is true in Norway.

Sir GERALD LENOX-CONYNGHAM: I have no critical remarks to make, but I should like to take this opportunity of expressing our gratitude for and admiration of the work that Mr. Goldthwait has described to us. When one sees these curves and their interpretation, one feels like the person who has listened to a Morse message for the first time and is very certain it contains a lot of meaning but it is not easy to guess what it is.

This method of investigating by means of seismometers seems to me to be one of very great promise, not only for the examination of glaciers but for many geological purposes. It is very encouraging to have the methods described as clearly as Mr. Goldthwait has described them.

One is aware that these methods have been used a great deal by companies engaged in searching for oil but, as a rule, the experts connected with those companies have been exceedingly unwilling to allow any one to obtain any knowledge of the nature of their instruments or of their methods of interpretation. So all those who are engaged in any branch of geophysics are delighted to have Mr. Goldthwait's clear and candid account both of his successes and of his difficulties. We thank him.

The PRESIDENT: We want to make the most of Mr. Goldthwait while we have him with us. There are many interested experts here. Dr. Harold Jeffreys.

Dr. HAROLD JEFFREYS: Some records I was reading last term for the Anglo-Persian Oil Company showed a large wave with about half the velocity of the longitudinal waves, and the question arose whether it was S or a Rayleigh wave. I decided ultimately that it was probably a Rayleigh wave. An explosion by itself can generate nothing but radial movement; anything else must be the result of reflexion, but when the explosion is near the outer surface the reflexion theoretically gives a strong Rayleigh wave. Some S movement may be excited too, but it would not be expected to have a sharp beginning or to be larger than P, whereas large Rayleigh waves are to be expected in any case.

There seems to be no reason against the bottom of the channel rising in the direction of flow. The ice is pushed along by the differences of pressure between places at the same level, and these are determined by the slope of the top, not of the bottom. So long as the top is sloping downwards the glacier will flow,

and its viscous drag will maintain motion all the way to the bottom; a river is not stopped by a depression in its bed. How the depression is made is another matter, but I think it should be made clear that there is no physical difficulty about the lowest layer of ice moving upwards.

The PRESIDENT: Mr. Oliver Gatty was on Mr. Glen's North-East Land Expedition. We should be glad if he would add a word or two.

Mr. OLIVER GATTY: I should like to congratulate Mr. Goldthwait on the excellent series of results he has obtained, and I speak as one who has not only had experience of the difficulties of trying to work with such instruments on ice but as one who has returned without any results whatever.

There are two points I want to touch on. The first has, again, to do with the initial offset time, and more particularly with the fact that Mr. Goldthwait showed different time-distance curves going one way and the other. I think he suggested that different depth of crevassing was responsible for the fact that with one wave he got one line and with the other wave he got two. As far as I can understand here, unless the depth of crevassing is comparable to the distance between the point of explosion and registration on the measuring instrument, the only effect of the different depth of crevassing will be a parallel displacement of the straight line along a climax. I do not quite see how that could bring up the thing just to one line.

Secondly, it seems very interesting listening to the suggestion of gouging out down below. I am no geomorphologist, but I believe the same question has been raised on corrie formation. It seems that this is interesting evidence of the theory that that can be accounted for by the ice gouging out deeply. Actually we had come by mere surface inspection to a rather contrary conclusion as to why the corrie was so steep behind: that the ice was melting away, and it looked very much as if the steep bit of the corrie at the back was due to erosion by sun and rain. I think the amount of erosion is probably a contributory factor. Just by looking when most of the ice had melted away it rather appeared that it was a matter of weighing up possibilities as to which explanation was the real one for the shape of the corrie.

Mr. RICHARD GOLDTHWAIT: It is difficult to show in words why the changing depth of crevassing might conceivably make two velocity-lines coalesce as one. If there are two regions, one of which has crevasses to a depth of 5 metres, the other of which has crevasses to a depth of 20 metres, each one will have a different time offset on the time-distance graph and there will be two parallel velocity-lines. However the case which I am postulating here is that the depth of crevassing increases from 5 metres at one end of a seismic profile to 20 metres at the other end. At points between these two ends waves must travel around crevasses of intermediate depth thus increasing the delay of wave arrival gradually from the shallow end to the deep end. The result is a single set of velocity-lines tilted steeper than normal and indicating false velocities. Perhaps a few minutes with a pencil and paper would make this clear. By proper application of this principle over a limited section of a seismic profile the two velocity-lines (each representing an ice layer) may be tilted, one flatter and one steeper, until the break between them is imperceptible and they appear as one.

Mr. M. SPENDER: May I raise one or two small points so that we may have the answers to them in the *Journal*? I remember in looking at Dr. Brockamp's curves that the arrival of the sound-waves from the explosion always made a nick on the record; and that suggests to me to ask that we might have the figure of the sensitivity, *i.e.* the ratio between the displacement on the records to the displacement of a particle of ice below the receiving instruments for Mr. Goldthwait's geophones.

We also have to remember that on expeditions sent out from this country there have been many difficulties with electrical measuring instruments. It would be well to have Mr. Goldthwait's opinion as to the reliability of electrical receiving instruments in the field as compared with the mechanical.

I hope too that a reference will come into the published paper to any work being done on the physical constants of ice, on which there is all too little material published.

Mr. RICHARD GOLDTHWAIT: The total amplification of the original instrument was supposed to be about 20,000 times. Undoubtedly the operating amplification which I realized was considerably less than that; I estimated it to be about 12,000 times.

I am not prepared to contrast the mechanical and electrical instruments wisely, because I have not used the mechanical instrument. But it seems to me that the prevalent idea that electrical instruments are useless on ice is quite erroneous.

There has been no very extensive work on the physical constants of ice, but it is certainly a point which needs to be taken up. I hope that what I have said and what others have written will encourage people in this country and in America and Germany to take up that question and carry it on.

The PRESIDENT: Mr. Goldthwait has been so good and ready to answer conundrums put by experts present that before we close I would like to ask if any other member of the audience wishes to ask him a question or two.

Mr. AUSTIN TAYLOR: I should like to ask whether the annual rate of progress of the glacier was worked out.

Mr. RICHARD GOLDTHWAIT: Yes, on Crillon Glacier we had the accurate measurement of the motion day by day. On Klooch Glacier, the small one, we measured bihourly motion during the course of one day, so we know fairly well what the motion is in the summer time. The motion of either glacier in the winter is hypothetical, but we believe it is fairly close to the motion rate in the summer. On that basis the distances between annual bands on Klooch Glacier agree very strikingly with the distances which that glacier moves each year. The same correlation has been worked out in the Alps.

The PRESIDENT: I hope you all realize that Mr. Goldthwait and Mr. Bradford Washburn came over to England just for a few days especially to give us the lecture of this afternoon and that to which we listened on Monday last. We greatly appreciate their kindness and the splendid effort they have made to put the results of their studies and work at our disposal. I am sure Mr. Goldthwait's paper, when it appears in the *Journal* with the numerous interesting points that have been raised, will be of great value and will have started discussion and further research in regard to several most important problems arising out of what he has been telling us.

I now ask you to join me in expressing our great appreciation and thanks to Mr. Goldthwait for his interesting discourse. I hope he will have further opportunities of continuing his valuable work and exploring activities connected with glacial problems.

# A HITHERTO UNRECOGNIZED MAP BY PEDRO REINEL IN THE BRITISH MUSEUM

ARMANDO CORTESÃO

THERE is in the British Museum an old Portuguese map, unsigned and undated, on vellum, coloured in green, red, and blue, but rather faded and spotted by damp. It measures 70×103 cm. in the largest dimensions, and is drawn on a scale of 1/13·5 M (10°=82·5 mm.). Its press mark is Add. MS. 9812, and it is described in the printed 'Catalogue of the manuscript maps, charts, and plans' (vol. ii, p. 33), as a "Map of coasts extending from the south-east of Africa to the Bay of Bengal, with the Islands, drawn on a plane scale, probably about 1600. The names in Portuguese. On vellum: 3 ft. 4 in. ×2 ft. 3 in."

The map shows the west coast of Africa, from the "manicõgo" (Congo River), the south and east coasts, with Madagascar, the Red Sea, Arabia, Persian Gulf, India, Ceylon, Gulf of Bengal, Malay Peninsula, north and east of Sumatra, some other islands of the East Indian Archipelago and the Indian Ocean. Numerous names are shown along the greater part of the coasts. Several islands bear inscriptions such as "aqui se ouera de perder Juhã da nova," in the João da Nova Island; "ilhas q achou o almjrãte do vasco," in the Seychelles Islands; "Ilha de baharein hõde se pesca o al Joffre," in the Bahrein Island (Persian Gulf), of old celebrated for its seed-pearl (aljofre) fisheries; "estas se chamã poluçibirã porẽ cada uã tê seu nome," between the Mergui Archipelago and Adaman Islands; "estas se chamã Ilhas de Rado," in the Chagos Archipelago; "ilhas de maluco donde a o crauo" (?), in the Moluccas; "aqui a as maças," in the "Ilhas de babane" (?)—Banda Islands.

Fortified towns are shown at Sofala, Mozambique, Mombasa, Melinde, Aden, and north, centre, and south of India, all displaying the Portuguese flag, which is also at the "manicõgo," Cape of Good Hope, north of Madagascar, north of "moguadaxo," between "fartaque" and "durfar," Diu, "queda," Malacca, east of Sumatra, island "sĩmbaba" (Sumbawa) and the Moluccas. Other flags, some with the crescent showing that the country is in possession of Gentiles, are seen in south-west of Africa, "ilhas de cariamuria" and north of the Gulf of Oman; also similar flags in part of the towns of Melinde and Aden. The centre of construction of the map is marked by an ornamental wind-rose, centre of a sixteen wind-rose system, nine of which are also ornamented. Through the middle of the map passes a scale of latitudes from 33° N. to 49° S. In the middle of Africa and east of the Indian Ocean are two scales of leagues, and the Equator, "linha equinocial," and the tropics, "tropico cancry" and "tropico cap̃cornj," are also marked. I was immediately struck by the resemblance between this map and that of Pedro Reinel, also unsigned and undated, in the Bayer. Armeebibliothek of Munich, formerly Hauptconservatorium der Armee. Though there are some rather important differences, one of the maps was certainly drawn from the other, the dimensions of the drawing being the same and the handwriting absolutely identical. The manner of representing the mountains, in green,

and drawing of wind-roses and Portuguese flags, are identical and are characteristic of Pedro Reinel.

In my recent work on early Portuguese cartography [1] I dealt with this mapmaker and demonstrated that the anonymous map of the Indian Ocean in Munich was drawn by the same hand that drew the other map in the same Library, signed by Pedro Reinel, one of the reasons being the perfect identity of the handwriting in both, which can be verified from the British Museum's specimen. I thought that the signed map of Munich was made in 1502 and the unsigned *circa* 1520, but I have now to change my mind as regards the later map. In the Bibliothèque Nationale at Paris there is another collection of five beautiful maps, four of them forming an atlas, usually known as the Miller maps, or Reinel maps. Though made probably by the two Reinels, father and son, I believe that the main responsibility of their execution may be ascribed to Jorge Reinel, and their illumination attributed to the noted artist Gregorio Lopes. I date these *circa* 1522±. Two other maps I ascribe to Jorge Reinel, one of western Europe and north-west Africa, signed only "Reinel," at present in Florence; and the other a fine world-map, unsigned and not dated. I think that the former was drawn a little after 1534 and the latter in 1519.

Pedro Reinel was an official cartographer at Lisbon, who served during the reigns of Kings John II, Manuel I, and John III, and was still living in 1542; his son, Jorge Reinel, also a distinguished cartographer, perhaps with a more adventurous life, was living in 1572. Pedro Reinel is the oldest Portuguese cartographer known, and with the Portuguese map of *circa* 1500, which is in the Bibliothèque Nationale at Paris, his map of 1502 and the map known as Cantino, are the earliest productions of Portuguese cartography. Two other works only by this famous cartographer are known at present, a circumstance which testifies to the value of this hitherto unknown map.

The Munich map measures about 68×131 cm., the British Museum one 70×103 cm. in its biggest dimensions. Nevertheless the scale is the same, and the drawing is more or less the same size in the two copies, the difference being due to the shape of the hides from which the vellum was made. In view of this, while the Munich map, being longer, has a large margin outside the drawing, in the London one the map proper extends to the edge; on the other hand the latter is a little larger than the former—the scale of latitudes in one goes from 39° N. to 40° S., and in the other from 33° N. to 49° S. Whereas the British Museum map has a single system of sixteen wind-roses, with a centre at 8° S., the Munich one shows a double system of sixteen roses each, with a total of twelve ornamented ones, and the centre of construction is situated on the Equator marked by a wind-rose common to the two systems.

The map of Munich shows the words "tropico de cancer," etc., in large letters, while in the one of the British Museum they are written in small letters and with a different spelling. Also on the latter the words "polo artico" and "polo amtartico" do not appear. In the Munich map the drawings of walled towns, seen in the other, are absent, and the placing of flags is sometimes rather different. In the Munich map the Gulf of Bengal does not bear

[1] Armando Cortesão, 'Cartografia e cartógrafos portugueses dos séculos XV e XVI,' vol. i, Cap. V. Lisbon, 1935.

any name, and the Persian Gulf has only the words "mar de persia," giving the impression of being unfinished; in the other we see "Reino de bẽgala" and "geofary" (?), near the Ganges River, and an inscription and names near the Mergui Archipelago and Andaman Islands, as well as more complete representation of the Persian Gulf, also with an inscription and several names, but not the words "mar de persia." Besides, the spelling of some words is different or they are not shown in the Munich map. In the British Museum map Sumatra, Java and other southern islands of the East Indian Archipelago are represented only by the north coasts, but in the Munich one all these islands have a complete outline, though quite fantastic.

The early maps of the Indian Ocean derive from Ptolemy directly, or indirectly through Edrisi and the Arab geographers. The modern cartography begins with the arrival of the Portuguese navigators, and the first real improvement is marked by the famous Portuguese map of 1502, called inaccurately the Cantino map. For some time however the influence of the Ptolemaic tradition continued, though attempts were made to reconcile it with the new knowledge, as in the Waldseemüller map of 1507. Robert Thorne in 1527, Grynaeus in 1532, in the *Novus Orbis*, Solinus-Nela in 1538, and Joh. Honterus in the *Rudimenta cosmographica* of 1546, continued to represent the Indian Ocean approximately like Waldseemüller in 1507. Nevertheless Waldseemüller in his *Carta Marina* of 1516 approaches already the Cantino type. This difficulty of adapting the new geographical knowledge to the Ptolemaic conception caused the greatest confusion. Some cartographers called Ceylon Taprobana, others gave this name to Sumatra, while others, like Reisch in 1515 and L. Frisius in 1522, ignored Ceylon and Sumatra and placed Taprobana between India and the Malay Peninsula.

Even among the Portuguese cartographers the Ptolemaic influence still lingered. The Pedro Reinel map of Munich, probably made in 1517, although a step forward in cartographical progress, retained in the East a big nameless gulf, clearly corresponding to the Ptolemaic "Sinus Magnus." But in Jorge Reinel's fine world-map of 1519 all Ptolemaic influence disappeared. In the Reinels maps of Paris, possibly produced under the direction of Pedro Reinel, *circa* 1522, a still more markedly Ptolemaic influence is found; near Ceylon there is even an inscription *ipsis verbis* copied from Ptolemy "Hic lapis gignitur herculeus . . .," and near Sumatra, here named "Taprobana insvla," there is an inscription saying that there are 1368 islands, as the cartographer tried to represent by a fantastic mass of islands.

Only by the middle of the sixteenth century did the Ptolemaic and Marco Polo's influence disappear completely from European cartography, and the representation of the Indian Ocean reach the type that, with small variations, prevailed for more than two centuries, until the navigations of the eighteenth century removed many non-existent islands and allowed the western coastline of Australia to be drawn accurately.

One of the most interesting features in this British Museum map is a group of four islands bearing the inscription "esta se chamã Ilhas Rado" (these are named Rado islands), south-south-east of Ceylon, between 1° and 3° south latitude. In the Jorge Reinel world-map of Munich alone is there a similar group of four islands, but there it is south-south-west of Ceylon, and without

any inscription or single name. In spite of this misplacement, 3° or 4° towards the north and 10° eastward, it is possible that these Ilhas Rado show the first modern cartographical representation of the Chagos Archipelago.

I think that these islands correspond better to the Chagos than to the four islands seen south of Ceylon in the Cantino map, or some of the Ptolemaic islands, because all the other fantastic islands south of the Indian Peninsula, even the Maldives, have disappeared; only the islands north and north-east of Madagascar and the Laccadives already known by his countrymen navigators remained, which shows that Pedro Reinel represented only the islands about which he had real information, and it is very probable that the Chagos Archipelago had already been discovered by the Portuguese.

El Edrisi, in the 8th Section, First Clima, of his 'Geography,' describes the islands El-Roibahat as lying near Serendib (Ceylon) and at seven days' navigation from El-Komor (Madagascar), close together and countless in number. This description corresponds exactly to the Maldive Archipelago, in which I include also the Chagos Islands, as its extension southward. I cannot find any reference to these Ilhas Rado in any old or modern map, book, or document, but it is possible that this name comes from the Roibahat which El Edrisi gave to the Maldives. I do not think that the Ilhas Rado have anything in common with the "Yle that men call Raso" of Jehan de Mandeville (Cap. LIX), which seems to be one of the East Indian Archipelago.

Perhaps the Arabian name and the information about this small group of islands, to-day called Chagos Archipelago, were brought to Lisbon by a Portuguese navigator who had discovered them; any one who knows the liberty used by the cartographers in writing native names in their own tongue, and the play they gave to their fantasy in placing them on the maps can easily realize how Roibahat (according to Jaubert's French translation of 1829) can appear as Rado (in the old Portuguese spelling of the word taken directly from the Arabs), and how it was misplaced 2° or 3° to the north and 10° eastward.

A comparison of the Cantino map with earlier maps reveals amazing progress in geographical knowledge, and we are led to the conclusion that some Arab or Malay maps were utilized. In the Cantino map the Maldives and Chagos are represented with extraordinary accuracy for the time. The three larger islands, south of the Equator, corresponding to the Chagos Archipelago, bear the names "aRissam," "tranom," and "Sapom," besides two groups of three smaller ones, one of which to the north of these is like a bank, and a similar one to the south. In nearly all the later maps of the Cantino type this representation of the Maldives and Chagos is more or less to be found. However the reproduction of the names is not always very faithful; for instance, the island "Sapom," spelt in the same manner in the Canerio becomes "Saponin" in the Ruysch (1508), "Saponi," in the Egerton 2803 (1510 ?), "Sapotu" in the *Carta Marina Portugalensium* of 1513. But in addition to these islands the Cantino map shows eastward a group of four islands, which I have already mentioned, one just on the Equator, named "armacora," and three more southward—"lissam," "sissam," and "montizmoto." These, in spite of being placed more westward, correspond better to the Ilhas Rado of the British Museum map, and still better to the similar

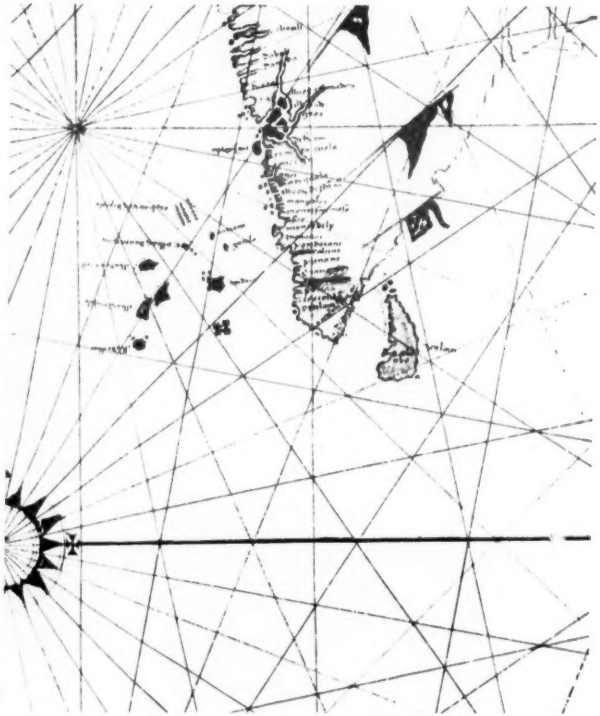
but nameless group of small islands in the Jorge Reinel world-map of 1519. But I hardly think any kind of connection can be established between them. In Pedro Reinel's other map of the Indian Ocean, at Munich, which I believe was made before that of the British Museum, there are no islands corresponding to the Ilhas Rado or the Chagos. It appears to me therefore that Pedro Reinel drew this group of islands independently of any influence from the Cantino map, and through special information brought by some Portuguese navigator, as suggested above. But it seems very peculiar that there is not the slightest reference to these Ilhas Rado in any other map. Only on later maps have I found an island "adu" (variously spelt), almost always south of the Maldives.

In the Turin Sevillan mappemonde of 1523 the Indian Ocean appears as in the Pedro Reinel chart of Munich, only with slight additions, showing the Laccadives but not yet the Maldives. In the world-maps of Diogo Ribeiro (1527 and 1529) the "Arcipelago de maldiuas" runs from north-west to south-east, 3° below the Equator, as an indistinct mass of islands, the latest of which possibly represent the Chagos Archipelago, but without any name. Nevertheless Ribeiro's maps show already many of the islands that we see in Pedro Reinel's two Indian Ocean maps, west, north, and north-east of Madagascar, and also the other islands east of the old "Insvla Divi Lavrentii."

The first Portuguese map where I can find the "Ilhas das Chagas" is Lopo Homem's mappemonde of 1554. This lack of world-maps and atlases by Portuguese authors between 1529 and 1554 does not mean that they were not made, but that they are now lost. Happily this gap has been filled by the Desceliers and Desliens mappemondes of the Dieppe School, undoubtedly made from Portuguese maps. On the Nicolas Desliens mappemonde of 1541 this group of islands appears, 5° to 7° south-west of the most southerly Maldive islands; the northern Chagos are drawn in the middle of a bank and named "chagas," the Pero dos Banhos as three small islands running south-west to south-east with the name "de garlaos," and the Diogo Garcia island has no name. Next comes the Pierre Desceliers mappemonde of 1546, drawn in the same way: but Pero dos Banhos is called "banez" and Diogo Garcia is called "Grace de Dieu." In the Desceliers mappemonde of 1550 the names are "Les chagas," "de b°. des bans," and "de dieu grace." In the Desceliers mappemonde of 1553 there are "Les chagas," "S : b°. des banez," and "grace de dieu." Perhaps "de garlaos" is corruption and misplacing of the "baixos de garajaos" seen more southward in some Portuguese maps of the epoch; "banez" or "S : b°. des banez," is a clear misreading of "I. de p°. dos banhos"; "de dieu grace" or "grace de dieu" is also an evident corruption of "de diogo gracia."

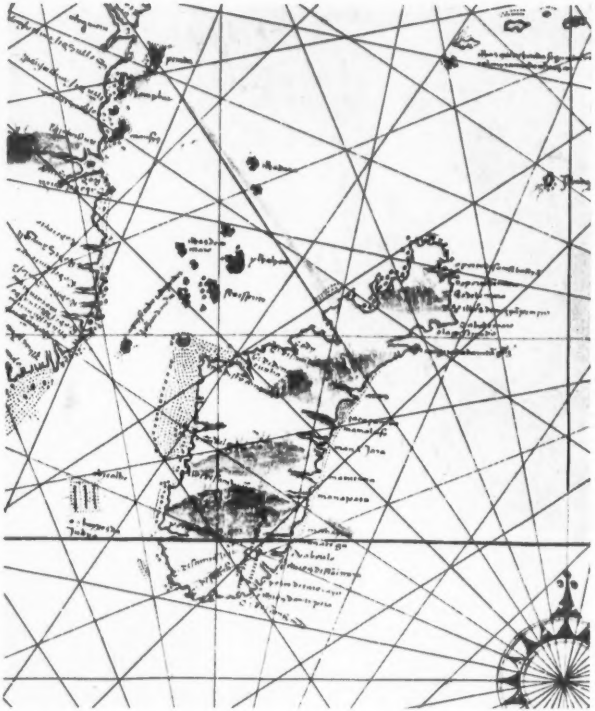
Unfortunately I have not been able to find any reference to the discovery of these islands or even the origin of the names Diogo Garcia, Pero dos Banhos, and Chagas, the same being the case with many other islands of the Indian Ocean, which cartographical research has yet to elucidate. The first reference I find to the "baixo de Pero dos Banhos" appears in the 'Roteiro de Diogo Afonso' of *circa* 1536.[1] This Roteiro, of which the original is lost, was fortunately translated and published by Linschoten, and a Portuguese copy

[1] A. Fontoura de Costa, 'A marinharia dos descobrimentos,' p. 296. Lisbon, 1933.



*The southern portion of India in the Pedro Reinel map of Munich (circa 1517)*

*Same section of the Pedro Reinel map of the British Museum (circa 1518), showing the Ilhas Rado (Chagos?)*



*Madagascar in the Pedro Reinel map of Munich (circa 1517)*

*Same section of the Pedro Reinel map of the British Museum (circa 1518), showing for the first time the island Santa Apolonia (Réunion or Mauritius)*

*Madagascar in the Pedro Reinel map of Malacca (circa 1517)*

*Base section of the Pedro Reinel map of the Indian Ocean (circa 1518), showing for the first time the island Santa* ***Apolonia (Réunion or Mauritius)***

is found in the MS. 'Roteiro de D. Antonio de Ataide,' a precious codex of the beginning of the seventeenth century belonging to the collection of Capt. C. R. Boxer. The references to the Baixo or Banco de Pero dos Banhos occurs on fols. 34 v, 50 v, and 52 v.

On the bank of Pero dos Banhos happened in 1555 the dramatic shipwreck of the *Conceição*, which is described by Manuel Rangel, one of the few survivors, under the title "Relação do naufrágio de nao *Conceição*, de que era capitão Francisco Nobre, A qual se perdeo nos baixos de Pero dos Banhos aos 22. dias do mez de Agosto de 1555," published for the first time in the 'Historia Tragico Maritima' in 1735. But from the description it is seen that the Baixo de Pero dos Banhos referred to is the one mapped north-west of the Maldives.

Comparing the British Museum's map of Pedro Reinel with its brother at Munich it is apparent the northern and eastern coasts only of Sumatra are drawn in the former, but in the latter the whole island is outlined. This should indicate that the London map was made earlier, if there were not other data strongly supporting the opposite opinion. If the absence of any name in the Persian Gulf and Gulf of Bengal in the Munich copy gives the impression that this map was not finished, several other circumstances show that the London one was made a little later and it was perhaps the cartographer's scruples that prevented him from drawing the south coast of Sumatra, then still unknown.

Besides the names in the Persian Gulf and Gulf of Bengal, the presence of the Mergui Archipelago, the "Ilhas Rado," the island of "samta apolonja," near the eastern coast of Madagascar, which we do not find in the Munich map and the more complete representation of the northern part of the Laccadive Islands, are clear evidence that the London copy was made later. The rather mysterious island of Santa Apolonia appears for the first time in this London map and later in one of the Reinels maps of Paris; it corresponds to Réunion or Mauritius, and in later Portuguese maps appears together with these two islands which bore then the names Mascarenhas and Cirne, between these and Madagascar. It was not yet possible to fix the year of the discovery of this island or who gave it its name, which did not finally disappear from maps until the seventeenth century. In the world-map of Pedro Reinel, of 1519, an island corresponding to Santa Apolonia appears together with Reunion and Mauritius, all under the designation of "ilhas mascarenhas" and southwards the imaginary island "Jº de lixboa," names not seen before. Also in this map appears for the first time, off the north-east coast of Madagascar the small island "samta mª" (Sta. Maria), which still bears this name.

In spite of the better shape given to the Persian Gulf and Gulf of Bengal in the two maps of Pedro Reinel, the configuration of the Malay Peninsula and the coast of southern China, already with some names marked, in the Jorge Reinel map of 1519, shows such considerable progress that, combining all these observations, we are led to the conclusion that the two maps of Pedro Reinel were made before 1519.

In the London and Munich maps appears for the first time, in the western coast of Madagascar, the "terra de s. amtonjo," corresponding to the "bahia de Santo Antonio," discovered in 1515 by the pilot Pedro Eanes, according

to Barros,[1] so that they could hardly have been drawn before 1516. The comparison also of the representation of the East Indian Archipelago in these maps and the map of Francisco Rodrigues, which I date at a little after 1512,[2] shows an evident progress which means a later execution.

When I dealt with the dating of the Pedro Reinel Indian Ocean map of Munich I said that the good representation given to the Gulf of Bengal might mean that the map was drawn after the exploration of João Coelho in 1516, of whom Antonio Galvão says that he was the first Portuguese "to drink the water of the Ganges." [3] Nevertheless the atlas of Francisco Rodrigues, in the Bibliothèque Nationale at Paris, made a little after 1512, already shows a fairly good representation of the Bengal Gulf, bearing the inscription "Este he o Rio de bamgalla" near the Ganges, and many particulars regarding the delta etc.; if this is not due to an unknown Portuguese voyage before 1516, Rodrigues must once more have utilized an Arab or Malayan map, which seems more probable. Besides, Pedro Reinel might merely have been inspired by the Ptolemy maps, which on Tabulae Asiae X and XI show a "Sinus gangeticvs" rather well shaped, with the "Ganges fluvius."

I think we may conclude that the two maps of the Indian Ocean by Pedro Reinel were drawn between 1516 and 1519, and that of London was made after its fellow in Munich. It is hardly surprising that in such a short period the same cartographer should make these changes, since the activity of the Portuguese in the Orient was then at its greatest, and that new geographical and cartographical information was continuously arriving at Lisbon, where Pedro Reinel, being an official map-maker, obtained it at first hand.

From a contemporary document we know that Pedro Reinel went to fetch his son Jorge Reinel at Seville, where he was making maps, some of which the father helped to finish, mainly in the eastern regions.[4] Very probably he took with him some new data, which explains the improvements shown in the eastern part of Jorge Reinel's world-map of 1519 over the maps previously made by his father at Lisbon.

In my book published last year I ascribed the date of *circa* 1520 to the Pedro Reinel's Indian Ocean map of Munich, but the study of this unknown map in London and a better consideration of the whole matter leads me to the conclusion that it was made *circa* 1517. I think therefore that I shall not be very far from the truth in attributing the date of *circa* 1518 to the present map, but one of the many precious jewels in the British Museum.

[1] 'Decada III,' Liv. I, Cap. I. See A. Cortesão, *op. cit.*, vol. i, pp. 285–286.
[2] *Op. cit.*, vol. ii, p. 129.
[3] 'Tratado dos descobrimentos . . .,' p. 40. Lisbon, 1563.
[4] See A. Cortesão, *op. cit.*, vol. i, p. 251, etc.

# THE TRADE OF THE UNITED KINGDOM WITH EUROPE

ROBERT W. STEEL

ONE of the most striking features revealed by a study of the trade statistics of the United Kingdom is the importance of the trade with Europe, particularly with the most neighbouring countries. So little is this trade emphasized to-day that it seems surprising at first; yet if the historical development of trade be borne in mind, this fact is quite naturally explained, for the modern trade is but the normal, though modified, continuation of what was, at one time, the only commercial activity of the country. Apart from the small, though highly valuable, overland traffic from the East, all the commodities of trade were of European or Mediterranean origin until the sixteenth century. The most important changes in English trade since earliest times have been in the nature of the commodities, rather than in the direction of the traffic, for even during the later Mediaeval period English exports were still mainly of raw materials. Some of the import traffic has continued throughout history right to the modern period, such as the trade in French wines, Baltic timber, and Spanish iron-ore. The tin-mining of Cornwall attracted traders from the Mediterranean, and probably from Scandinavia too, at a very early date, whilst copper, lead, and gold (mined in Cornwall and Wicklow) were also important at various periods, such as during the Roman occupation, which has its commercial as well as its military aspects, when there was also a considerable export of corn to other parts of the Empire. In the centuries which follow there was an intermittent though often considerable export of corn, and by the tenth century there are references to a thriving export of wool and to an import of iron-ore from Spain.

There were three major raw material exports of the Mediaeval period: tin, coal, and wool, with cloth as a fourth export, though this was only partially manufactured, the dyeing and shearing being done after export. From various sources of evidence, including the lists contained in the 'Libelle of Englyshe Polycye,' [1] written in 1436, probably by Adam de Moleyns, we can see that, though many and diverse, they are almost exclusively of European origin. "The geographical area covered by English trade . . . was co-extensive with the whole of North Western and Western Europe. . . . The most ancient and most active channel led along a short sea route to the Low Countries, England's nearest continental neighbours, and the commercial hub of Europe." [2] The tin export, controlled by Venetians and mainly directed to the Italian pewter trade, revived in the fourteenth century with the passing of the Stannary Laws. A considerable trade in coal had already developed between Newcastle and the Low Countries. But most flourishing of all was the export of wool, which having no European superior was in great demand especially in the Low Countries and in Lombardy, which was usually reached by sea through the Straits of Marrock (or Gibraltar). All the leading towns

[1] The references in the footnotes are to the edition edited by Sir George Warner. Oxford: Clarendon Press, 1926.

[2] Power and Postan, 'English Trade in the 15th Century.' Preface, p. xviii.

were closely linked to the continent—London, Lincoln, York, Hull, Norwich, and Winchester—whilst Calais' importance as a wool staple, so long as it was in English hands, is highly significant, being almost symbolic of the continental interests of the woollen trade. The author of the 'Libelle' [1] recognized its true importance:

> "And for the love of God and of his blisse
> Cherish ye Calaise better than it is."

This important trade was the main concern of the Merchant Staplers, and its later decline was caused not so much by a decreased demand and by the competition of other supplies as by the enormously expanded home consumption. The rivalry between English and Hanse Merchants was particularly keen in the export of semi-manufactured cloth. The charter of 1407 is especially significant since it marked the real beginning of the Merchant Adventurers (to the cloth trade what the Staplers were to the wool export trade) and particularly referred to trade with the Low Countries. The trade, exclusively European, was closely related to continental policies and jealousies, and foreigners took a very large share until late in the sixteenth century, when the Hanse merchants forfeited their privileges.

Imports from the Baltic included timber, furs, pitch, and iron ores; from Flanders, cloth and fustian; and from the Low Countries, dyes, onions, cabbages, and fish. The wine trade was in Gascon, Rhenish, and sweet Levantine wines. France also imported into England much salt, which was in great demand in mediaeval times. Mediterranean imports were:

> ". . . fygues,[2] raysyne, wyne, bastarde [3] and dates,
> and lycorys, syvyle oyle and also grayne." [4, 5]

The oil was needed for oiling the wool, and thus England was already partially dependent on imported materials for her industries. The Genoese imports, according to the 'Libelle,' were more utilitarian than the "nifles and trifles" from Venice and Florence, which being largely of Eastern origin, were the only mediaeval imports from sources outside Europe and the Mediterranean. Though the shipping of this period was still mainly in Mediterranean hands, English seamen had gone farther afield both within and without Europe, though this latter expansion was still only slight and aimed mainly at the extension of trade on the borders of Europe, or at the discovery of shorter and unrestricted routes to the East. This advance profoundly influenced subsequent wars, which, though intensified by religious feeling, were primarily fought for commercial supremacy.

During the whole period since 1600 there has been a gradual relative decline in the importance of European trade, accompanied however by a great absolute increase in the amounts handled. A good example of the size and rapidity of this increase is the American trade which had so expanded by 1750 that it equalled the English trade with the whole world in 1700. In 1600 non-European trade was negligible except for the overland traffic from the East, and in 1700 European trade was still nearly four-fifths of the total.

[1] 'Libelle,' p. 42.
[2] Figs.
[3] Not corn, but a dye.
[4] A sweet kind of Spanish wine.
[5] 'Libelle,' p. 4.

A century later the share had fallen to less than three-fifths, though the value had increased meanwhile from £9,000,000 to nearly £40,000,000. In the nineteenth century the relative share still further declined to two-fifths of the total, though there was an even greater absolute expansion to over £300,000,000. European trade was thus continually increasing, though usually at a considerably slower rate than the trade with other countries; between 1860 and 1900 it increased by one-half however, whereas that of the British dependencies increased by little more than one-quarter. Since 1600 the colonial expansion has been very great, and the colonial aspects of the Navigation Acts and of the doctrine of Mercantilism were important. But though these Acts did effect a new orientation of English trade towards the Atlantic, they also struck at the Dutch carrying trade, within and without Europe, whilst many European commodities were specifically mentioned in the acts. Indeed, as Mr. Ogg's work [1] shows, the staple imports and exports were still very similar to those of the Mediaeval period. The Methuen Treaty of 1703 with Portugal, the attempted, though unachieved, arrangement with France in the Treaty of Utrecht, and Pitt's Commercial Treaty with France in 1786 are three examples of the many efforts to facilitate and extend eighteenth-century European trade. Napoleon recognized England's dependence upon the continental trade when he formulated the Continental System, which aimed at the total exclusion of England from this trade. How serious the threat appeared may be judged from the promptitude of the retaliatory Orders in Council of 1807. Simultaneous with the great imperial expansion of the nineteenth century, the European trade increased, particularly in the coal, iron and steel, and textile trades, which during the century multiplied four, eight, and six times respectively. The English share in the European trade has, in fact, always been more important than the partial monopoly in the much smaller Imperial trade. The generalization that British trade may be equally divided into three groups—that with the Empire, with Europe, and with the rest of the world—though not quite accurate, has a certain value, emphasizing as it does the continued importance of European trade down to the present day. In the present century there have been such fluctuations and disturbances that no one year can be taken as a standard. Figures for 1913 are valuable, provided it be remembered that this was the climax to a series of good trade years, and that in any case a return to pre-war conditions is only in rare cases at all probable. For most countries the statistics for 1924 are the first normal post-war figures, while those for 1929 are the latest normal figures before the renewal and intensification of the trade depression. But for individual countries and individual commodities, it is often better to select figures from other years. In the following account trends and conditions since 1929 have normally been disregarded; it may be generally said that German political and financial instability is reflected in a decline in all branches of their trade, and that the U.S.S.R. and Denmark have, on the whole, taken an increased share in British trade. In 1929, 30 per cent. of the total trade (by value) of the United Kingdom was with the Empire, and over 37 per cent. with the countries of Europe. The Empire supplied only 26 per cent. of the imports, but took 41 per cent. of the exports, whereas Europe

[1] David Ogg, 'England in the Reign of Charles II.'

sent over 37 per cent. of the imports and received 31 per cent. of the exports. Nearly 70 per cent. of the re-exports go to Europe however and only 13 per cent. to the Empire. The Empire is thus especially a purchaser of British manufactures, whereas Europe is more important as a supplier of raw materials and foodstuffs, and as a customer in the entrepôt trade. It is noteworthy that in recent years trade has increased both with individual countries and with Europe as a whole.

The imports into Britain are especially of bulky commodities which must avoid long distances and consequent high freight charges. Foodstuffs and raw materials do indeed figure largely in the non-European import trade, but only if Europe cannot supply the quantity, quality, or type demanded. The factor of distance operates both between European and other producers, and between one continental country and another. Thus in 1929 Britain's five nearest neighbours (Germany, Denmark, France, Belgium, and the Netherlands) were, in that order, the leading European exporters to Britain, sending two-thirds of the total import from Europe, whereas the next five, more remote, producers only supplied a quarter (Sweden, the U.S.S.R., Spain, Italy, and Finland). These ten countries, with Norway and Switzerland, accounted for 95 per cent. of the European, and over 35 per cent. of the total, imports into the country in 1929. The high position of Denmark, two-thirds of whose exports come to Britain, emphasizes the extreme dependence of this country upon imported food supplies; in 1932 Denmark actually usurped, though probably only temporarily, the leading place normally occupied by Germany. Trade with the Netherlands is also largely in dairy produce and other foodstuffs. The imports from the U.S.S.R. are increasing, though it must be remembered that many of the pre-war Russian exports came from what are now the Baltic States and Poland, under whose statistics such trade has appeared since 1921.

British exports to Europe, though considerably less than exports to the Empire, are by no means unimportant, accounting for nearly one-third of the total export trade. Whereas the Empire as a whole is still but little industrialized, and the considerable demand for manufactures is normally satisfied by the United Kingdom, the leading European traders not only supply most of their own demand for manufactures but are also keen rivals for foreign markets. The import of manufactures by the industrial countries of Europe usually has some political, economic, or technical reason. The importance of Britain's nearest neighbours is again revealed by the order of 1929—Germany, France, the Netherlands, Belgium, Italy, and Denmark. The Danish market continued to expand and surpassed both Italy and Belgium in 1932 and again in 1933. There has also been a relative expansion of the French and Dutch markets, though the German figures are now much reduced, both as compared with those of 1929 and of 1913. Nearly one-tenth (by value) of the imports of colonial and foreign produce are re-exported, two-thirds of this entrepôt trade being with European countries. Liverpool, handling from 10 to 15 per cent. of this trade, deals especially with non-European traffic, whilst Southampton (10 per cent.) has colonial in addition to its continental interests. But nearly all the other ports sharing in this traffic deal primarily, and often exclusively, with continental traffic, such as the Humber ports, Harwich, Dover,

Folkestone, and Newhaven; whilst London, still the world's largest entrepôt centre and dealing with three-fifths of the British re-exports, sends most of these goods to Europe, particularly to Germany, France, and Belgium. This trade has been declining for many years and especially since the war, particularly with regard to European countries, many of which now import foodstuffs and raw materials direct from the producers, or through one of the entrepôts which compete with London.

Before the war 25 per cent. of the coal mined in the country was exported, and 9 per cent. was bunker coal. By 1929 there had been a 30 per cent. drop in the volume of the exports, but of the diminished total production 21 per cent. was still exported and 7 per cent. was used as bunker coal. In 1913 the exports to South America, Egypt, and certain coaling stations was important, but over 80 per cent. went to European purchasers. In 1929 this proportion was 71 per cent., the decline being largely caused by the closed Russian market. The use of petroleum, hydro-electric power, and other substitutes had everywhere increased since the war, a new competitor in the coal export trade arose in Poland, some German reparations were paid in coal, whilst many coal resources in other countries were developed during the war, when British supplies were irregular or unobtainable. Russia, an importer of 6,000,000 tons in 1913, has so pushed the development of her own resources that in spite of the enormous industrial expansion the imports of British coal are now negligible. Norway and Sweden have developed their hydro-electric power and export some to Denmark, so that their coal import has by now been more than halved. Germany and the Mediterranean countries have developed their own water-power, lignitic, and other fuel resources, whilst Poland has captured most of the coal trade of Eastern Europe. This restriction of European markets has seriously hit the British coal industry, and only to France, Belgium, and the Netherlands are there increased exports. In these countries the industrial expansion has been so great that not even the exploitation of new fields and of water-power resources, the temporary possession by France of the Saar coal, and certain reparations payments in coal, have been able to satisfy the expanded demand for coal. Of the four major areas producing for export, even South Wales finds important markets in Southern Europe, whilst those on the East Coast—the ports of Northumberland and Durham, of the Humber, and of the Firth of Forth—are particularly closely linked with Europe. The coal industry probably least of all industries could afford to dispense with these European markets.

Only the higher grades of a heavy commodity like iron ore can be transported over long distances, and Europe has always been the main source of British imports, which first rose to major importance in the 'seventies when large quantities of non-phosphoric ores were obtained from Northern Spain, which has been an exporter, though on a small scale only, since earliest times. Half of the imports still come from Spain, with Scandinavian (mainly Swedish) ores (which being phosphoric, though with a high metallic content, came on the market rather later) accounting for a quarter. Most of the remainder comes from various parts of North Africa (the combined amounts exceed the Scandinavian figures) and from Normandy. These imports, making up one-third of the available supplies in the country, are thus entirely from European

or North African mines. There were other iron imports even in the eighteenth century when they came from Sweden and Russia and were double the amount of home-produced iron. To-day these imports, of the cruder finished articles and various unfinished raw materials (blooms, billets, and girders), are almost entirely from European countries, especially neighbouring France, Belgium, and Germany, which for various reasons are able to undercut the British producers. The importance of distance and of freight charges is shown by the advance of Belgium and France which, from their modern and highly efficient reconstructed plants, sent 69 per cent. of the imports in 1929 as compared with 27 per cent. before the war, whereas the share of the more distant German and Swedish producers has been correspondingly reduced.

Europe is, in many trades, an importer into this country rather than a customer, and in 1913 took only one-quarter of the iron and steel exports, and in 1929, less than one-sixth. The export is mainly to the British Dominions and India, and amongst the ten leading customers the only European countries are Belgium and France, the latter's import having been halved since 1913. As imports have, on the whole, shown a tendency to increase as compared with exports, the position of Europe has become of relatively increased importance.

The most important of the allied industries is the manufacture of tin plates, and though no tin is imported from the continent, exports of tin plates go to every European country except Germany, especially to the Netherlands (normally taking the second place after Australia), Belgium, and Spain. The export to Europe is however small compared with the export to imperial and tropical countries, and this bias is even more marked in the case of galvanized and terne plates. Exports of textile machinery to Europe have decreased much less than those to Asia (although the Asiatic market is still by far the most important) and the Russian and Italian markets were recovering until 1930. One-fifth of the 1929 export was to France, Belgium, and Germany, a high proportion in view of the fact that these countries are themselves producers of machinery. A century ago only one-quarter of the wool used in the woollen industry was imported from Central Europe. To-day the home clip makes up only one-fifth of the total supplies available, although much is still exported on account of its high quality and reputation. Except for special wools, such as Silesian or Saxon wools, the import is mainly from outside Europe, though much of the imported shoddy and semi-manufactured tops and yarns is of European origin. Woollen exports, accounting for two-thirds of the total export in 1700, to-day make up only 6 per cent., and Europe is no longer the only market. Germany remains the best customer, her demand in 1913 being not only double that of Canada, but nearly the equivalent of the combined demands of Canada, Australia, Japan, and South Africa, the purchasers next in order. In 1929, though the Canadian figure had doubled, Germany still imported half as much again. So long as Europe remains one of the most important customers there is a serious threat to the British export trade in the establishment in many European countries of woollen industries, facilitated by the fall in raw wool prices whereby the production of the cheaper fabrics has been favoured. The re-exports of wool to Europe from the Coleman Street Exchange in London are still considerable.

Cotton has not been grown recently on any large scale in Europe, though in earlier days the main supplies came from the Levant or Cyprus or from the East through Venice. Being a gradable commodity cotton has not given rise to any extensive entrepôt trade. The export of piece goods is almost exclusively to non-European countries, whereas the yarn trade is mainly European, though India is the third customer, and it is the reduced Indian demand which has been mainly responsible for the post-war decline in the trade, for the European market, though fluctuating, decreased only slightly until 1930. Germany and the Netherlands take more than two-fifths of the total, whilst France, Belgium, and Switzerland are other important European customers. All the textile industries in these countries have had to follow Lancashire in the increasing specialization in the finer and more valuable products. Four-fifths of the raw material for the linen industry is imported, all from European sources. The export of four-fifths of the production is, on the other hand, mostly to countries outside Europe. Of this import Russia sent three-quarters in 1913, and Belgium the bulk of the remainder; in 1929 Belgium sent over two-fifths, with rather less from the Baltic States, the source of most of the former Russian export. Both in 1932 and in 1933 imports from Latvia exceeded those from Belgium. Historically the silk industry has been closely linked to Europe and the Levant; but imports of raw silk from Italy and France at the present day are small compared with the Asiatic import. As in the linen industry, Europeans are rival producers and not only take few of the British exports, but are always ready to step into any British-controlled market should opportunity arise.

The import of dyes and drugs and of the raw materials for the home chemical industry amounts to 2 per cent. of the total import trade, whilst the export of heavy chemicals and other products amounts to 4 per cent. of the total export trade. The European market is monopolized by the vast German industry, which is the chief supplier of this country. The pottery and paper industries, certain of the non-ferrous metal industries, and a number of the other smaller industries of the country depend partly upon imports from Europe for their raw materials and sometimes upon European markets for the sale of their products. The entrepôt trade to Europe is also considerable in a number of commodities not of European origin, such as rubber, petroleum, and hides and skins; the re-exports of hides and skins for example are equal to one-third of the retained imports.

Although Europe itself is an importer of foodstuffs, the imports from Europe into this country are considerable, particularly in fresh foodstuffs, where proximity to the markets is a great advantage. Denmark, the Netherlands, and the Irish Free State are the main sources of supply, whilst cereals come from Eastern Europe, sugar-beet from Central Europe, and a variety of sub-tropical and temperate fruits from Southern and Western Europe. The shipbuilding industry not only reflects general trade conditions so well that it is often called a "trade barometer," but it also shows the great European share in the new tonnage launched each year. The United Kingdom, Germany, Holland, Italy, and France, normally ranking in that order, own about four-fifths of the new tonnage built, much of which consists of relatively small general type vessels, designed for coastwise and continental traffic of

all kinds. Though small, they travel but short distances, and so in one year make many voyages and transport many goods. Very efficient European-owned coasting vessels have seized a considerable share even in the British coasting trade during recent years.

Only three major ports—Liverpool, Glasgow, and Bristol—have few European connections. The coal trade of South Wales closely links Cardiff and Swansea to the Mediterranean countries, whilst Southampton's historic links were with the coast of Northern France, and the passenger, entrepôt, and special traffic in this direction remains important. To-day London's interests are world-wide, but it was European trade which first made her supreme, and most of the great European trading companies had their head-quarters near the Thames. The great benefit derived by London from the sack of Antwerp in 1551 suggests how close and important were these European links. To-day the port handles one-half of the total imports of butter and eggs, and one-quarter of those of iron, steel, and timber—all of which are mainly of European origin. Most of the goods unloaded outside the large docks are from Europe, as are the cargoes discharged from smaller vessels in the Surrey Commercial Docks and the London and St. Catherine's Docks. Hull has a similar history of continued activity and handles a similar diversity of cargoes. It is predominantly an importing port for wheat, oilseeds, butter, bacon, and timber, mainly from European countries. The other Humber ports import timber, especially pit-props, and iron ore from Scandinavia, and export coal to the Baltic. Leith and Granton resemble Hull, and Glasgow can only be primarily an exporting centre because it can depend on these eastern ports for its food and industrial supplies. Excluding the ports for the Irish goods and passenger traffic, most of the other ports of the country are on the east or south coasts, usually as near to Europe as possible, for they are chiefly engaged in the continental trade, being importers rather than exporters, except for the coal-exporting ports—the Tyne ports, Sunderland, Blyth, and Middlesbrough. British trade has too often been thought to be entirely similar to that of the great ports of the West Coast, but the number of these smaller ports and the value of their trade does reveal something of their real importance and of the true significance of the continental traffic. The large vessels of the larger shipping companies probably deal with much less of the country's external trade than we imagine. It is significant that the tonnage of the coastwise trade is normally one-third of that of the foreign trade, and small vessels probably deal with a similarly large volume of the foreign trade, particularly on and around the North Sea.

If this trade with Europe is really so important there must be reasons to explain why it is so often disregarded or under-estimated. The insular position of Britain is enormously strengthened—psychologically, if in no other way—by the racial, cultural, and historical links with the United States and the Empire. This orientation of interests, it has been pointed out, is shown by a glance at the foreign news page of *The Times* or by an analysis of the direction of the foreign mails of the country. Imperial statistics are frequently grouped together in a way that is seldom done for Europe—certainly very seldom for direct comparison or contrast with similar figures for the Empire. American and French geographers and statisticians have recog-

nized the collectivity as well as the individuality of the countries of Europe rather more clearly than the British, and so have better seen the true importance of British trade with neighbouring countries. Confusion has also arisen by too direct a correlation, leaving no room for any other influential factors, of the colonial and the commercial expansion of both the seventeenth and the nineteenth centuries. The mistake has also often been made of regarding the trade of Liverpool or Glasgow as representative of the country's foreign trade, rather than the trade of London or Southampton. It has also not been fully realized that the greatly increased share in the country's trade, particularly in the import trade, by the United States and the Empire during and immediately after the War was only temporary.

As industry continues to expand outside Europe the export trade of the United Kingdom can only escape serious diminution if the exports to European countries are considerably increased, whilst even if imports from outside Europe increase, those from Europe, particularly the fresh foodstuffs, must remain of fundamental importance. It is therefore quite conceivable that trade with European countries will actually show an appreciable increase, relative even if not absolute, though British trade will continue to be world-wide, favoured as it is by the country's intermediate position—intermediate between Europe and the Empire, and between Europe and the United States of America. So great is the United Kingdom's economic dependence upon commerce that there can be no isolation or separation from any other part of the world, for in modern economics the only possible view is world-wide and international.

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*The Council have awarded to this Essay the prize offered for an Essay of not more than 5000 words: either a critical survey of recent additions to knowledge in a limited geographical field, or a discussion of some problem in its geographical aspect. The writer has made some slight revision of the Essay before publication.*

# TRAVELS IN THE WESTERN SAHARA, 1934–35

THÉODORE MONOD

*GEOLOGY.*—Having worked in areas which have as yet hardly been touched by geological exploration or are in most cases still entirely unexplored, I have been able to make some observations which may be of use. In the Mauritanian Adrar I made for the first time a complete section of the Tassilean series, extending from the Cambrian to the Devonian, based on various fossiliferous horizons and, in particular, on my discovery of Graptolitic Gothlandian (July 1934); one can distinguish here, as in the Central Sahara, "upper" Devonian sandstones resting on papyraceous Gothlandian schists which overlie a thick Ordovician arenaceous series, itself overlying (in such perfect a conformity that the fixing of a Cambro-Silurian limit remains largely arbitrary and that one may consider the aggregate of pre-Gothlandian formations as constituting a homogeneous whole) a schisto-calcareous series of a thickness of several hundred metres, resting on the crystalline pre-Cambrian bed and itself containing arenaceous intercalations. These are sometimes important and it is essential not to confuse them with the Ordovician, or "lower" sandstones, of the Algerian Sahara. This analysis of the Mauritanian primary formation, carried out towards the south, across the Tagant, as far as the massif of Afollé, and followed towards the east along the cliff of Tichitt-Walata as far as the Fagibin, throws a most satisfactory light upon the work of the Sudanese geologists. It at last gives an opportunity in the future for comparing without difficulty the terms of Sudanese, even Guinean, stratigraphy with that of the western Sahara and southern Algeria. I have myself, further, by the sandstones of the Fagibin, Tendirma, Tendifarma and of Debo, linked up the "lower" sandstones of Tichitt-Walata with those of Bamako, which are undoubtedly homologous with the former and consequently with those of Tagant and Shingeti. North of Timbuktu I was able, on several different journeys, to make sections in its complete width, as far as the Hank and the granites of the Karêt, of the north side of the Arawan syncline, where I recognized: (1) a palaeozoic series which extends from the stromatolithic Cambrian to a lower carboniferous formation overlain concordantly by argilo-gypseous strata and which may represent the middle Carboniferous or even more recent periods; (2) the fossilised wood sandstones of the intercalary Continental series unconformable with the foregoing.

Among the principal discoveries in this area mention may be made of: (1) the undoubted identical constitution of the sandstones of Foum el Alba, El Mraiti, In Eshaye, and of the Khnashish, all of which belong to the intercalary Continental series and certainly not to the palaeozoic, as had been supposed; (2) the unconformability which separates the Khnashish sandstones from the underlying gypsiferous motley clays which, contrary to what has been thought, lie conformably on the carboniferous limestones of the El Hareïsha hammada; and finally (3) the total absence of strata prior to the Carboniferous around Taüdenit, where the primary series is normal, homogeneous and without any access to the pre-Cambrian. The discovery of Gothlandian of Tiniulig, 650 km. from that of Sharania and 400 km. from

Adrar des Ifoghas
Timbuktu
Niger
Senegal
St Louis
Dakar
Nouakchott
Route
Miles
ATLANTIC OCEAN
AWKER
AZAWAD
HODH
HIRAIYE
Mjebir
Tichitt
Aratan
El Glatt
Walata
Nema
Fagibin
Araouan
Arezzaf
Timellin
Mabrak
Tindirma
Foum el Alba
El Khnachish
El Keiss
Tindulg
Agueli el Melha
Adjil
Shingeti
Atar
Tidjika
Kasr el Barka
Mudjeria
Alig
Tamshaket
Agueraktem
Teghaza
Tasiaudenit
Tasiarine
Shegga

that of El Glatt, completes the delimitation towards the west of the syncline of Arawan and of the zone inaccurately called Jauf on all the maps.

There do not appear to be any volcanoes at Taüdenit, but from In Daguber to Mjebir (550 km.) and from the Khnashish to the Hank (350 km.) I found an extraordinary abundance of doleritic lodes. These lodes become less plentiful towards the west. Throughout the whole area of the Mauritanian plateaux I know of only three lode-like veins, but they become more numerous in the Hodh. They penetrate the whole of the primary series as far as the Carboniferous and the motley clays overlying the latter; only in one case, to my knowledge, do they reach the intercalary Continental. In the eastern part of the areas I have investigated I was able to study a fossiliferous series extending from the upper cretaceous to the Eocene, and overlain by "Nigerian clayey sandstones," an azoic, detrital, continental formation very comparable to the *gur* region of southern Algeria. It seems to run eastwards, north of the Azawad, but does not seem to go beyond the almost completely peneplained anticlinal zone of Fagibin–Tadrart–Erug.

From the foregoing remarks a geological picture can be put together of the structure of the western Sahara. Between the submeridian anticlinal zones of the Mauritanian Tiris and of the Adrar of the Ifoghas the huge dissymmetrical groove of the Arawan syncline is interposed, the sides of which are composed of plateaux superimposed on one another in the form of steps and whose axis is marked by the enormous lacustral deposits of the Jauf and of the Azawad.

The Quaternary fresh-water deposits particularly attracted my attention. They are plentiful in all the depressions in the form of molluscan limestones, muds containing fossilized crocodile excrement and reeds, slimes containing diatoms, sandstones with fishes, osseous breccias containing hippopotamus and crocodile bones, various sands, travertines containing vegetation and molluscs, stalactitic crusts, gravel, black forest soils containing achatina, carboniferous beds, saline or gypseous deposits, etc. In this country of monoclinal construction, where the cliffs succeed one another and where there is no hydrographic system east of the Adrar, linear catchment zones stretch along the foot of the steps; the "sebkha" is the necessary complement of the cliff, as is recognized by a geographical vocabulary in which the *dhars* are constantly opposed to the *batens* or the *khnashish* to the various *jauf*. Local topographical accidents though these may be, they can however attain considerable dimensions. Asselar, Taüdenit, Teghaza, Aguraktem, Tiniulig, the temporary pools of the Azlef, the huge *sebkhas* of the Hank are examples. On the axis of the syncline, and to a lesser extent in the Awaker opening, there are veritable internal seas. That of the Miraiye must have had a diameter of several hundred kilometres. The upper Niger was for a long time an affluent of this huge Chad-like depression which, on the other hand, never had any connections with Taüdenit nor, it would seem, with the catchment zones of the Tanezruft, which must have belonged to an entirely different basin. My impression is that it will be possible to distinguish in the extension of the Quaternary lakes two maxima of decreasing amplitude and separated by a phase of severe desiccation in the course of which the dune system may well have come into being. The ancient palaeolithic industries seem to mark

the banks of the first lake, and the neolithic sailors fished with bone harpoons and fishhooks made of stone or bone for the percidae and the siluridae which swarmed in the second.

I have found marine shells, but always in centres which are or have been inhabited. At Timbuktu I studied on the spot the strata of marginellidae deposits in which I was not able to recognize any characteristics of a natural formation. The conclusion from my observations does not support the suggestion of a recent sea in the region. Special chapters in my more detailed report will deal with tectonic and palaeogeographic problems, to a detailed study of the fossil man deposit of Asselar, to the salt-mines of the western Sahara, to the present forms of accidentation, to an attempt at classification of *regs*, to the results of my hypsometric measurements, and to regional descriptions of the districts visited.

*Climate and Biogeography*.—A meteorological diary, comprising more than thirteen months' observations, made thrice daily, and notes on all the water-holes met with, will form a basis for some remarks on the climate of the western Sahara. My plant collection, comprising more than nine hundred specimens, is interesting owing to the fact that the places at which they were gathered extend, in longitude, from the Atlantic coast-line to the hills of the Ifoghas and, in latitude, from the Sahelian baobab steppe, across the typical Sahara with its *Cornulaca* and *Andropogon pungens*, as far as that part of the desert which has palaearchic relationship with *Asphodelus*, *Rhus*, etc. Having crossed the limits of Saharan and Sahelian flora about ten times, I intend to take up again in greater detail the question of the southern limit of the desert.

The zoological results, while not very numerous, include however some useful evidence, dealing in particular with fresh-water fauna, either permanent (*geltas* of the Tagant and of the Adrar) or temporary (*dayas* of the Aguraktem region). The sub-fossil specimens are fairly well represented (molluscs, fishes, reptiles, and mammals).

*Prehistory and Archaeology*.—The specimens of prehistoric industry (stone, bone, pottery), which were gathered, amount to several thousand. The most important items perhaps are a rich series of Mauritanian and Sudanese bifaced implements, the remains of bone tools, harpoons, and fish-hooks (Awaker, Azawad, Tilemsi), and numerous objects of neolithic adornment. The study of the sites on the spot will no doubt enable a comparison to be made of the principal stone industries with the variations in the level of the expanses of fresh water.

The cliffs to the west provided several hundred rock engravings (and a few paintings) ranging from archaic, precameline, and analphabetical to recent cameline Libyan-Berber with accompanying *tifinagh*, and finally to modern Islamic. The excavation of the tombs at Lemgader, where there are slabs embellished with archaic engravings, seems to establish them as neolithic. The neolithic agricultural and pastoral Saharan man, in various localities a fish-eater, followed by a "Libyan" civilization of nomad hunters, mounted on camels and horses, employing two-wheeled chariots, using metal, in all likelihood itself dating back several thousand years, may well be more ancient than is generally believed. The rock inscriptions are innumerable. *Tifinagh* is plentiful, a witness to the expansion in olden times of the "Berbers" across

the whole of the Sahara as far as the Atlantic. Arabic inscriptions are sometimes ancient and have provided me with curious graphs and some amusing decorative stylistic versions of the *shehada*. The most curious epigraphic texts of the Mussulman epoch are some lines worded in cryptographic systems, which have separate characters known as *saryaniyya* and *hibraniyya*. The text of the Tarf esh Sherif, examined some years ago by M. Marcel Cohen and which I have re-examined, is in *hibraniyya*, a secret alphabet of which the key has been given to me by a Shingeti scholar. Numerous lithic monuments (tumuli, crescents, enclosures, alignments, etc.) have been noted and some have been excavated.

The exploration of the archaeological sites has given some interesting results in three regions: (1) in the Adrar, where I examined various so-called "Portuguese" ruins; (2) in the Rkiz, where I wanted to re-examine the remains of Tegdaust which Boéry supposed might represent the Audaghost of the Arab geographers; and finally (3) in the foundations of Teghaza. I was able here to recognize, in addition to the site of the old salt-mines which Grosdemange took for a "town," the remains of two settlements, one situated to the north-west, the other to the south-east of the salt-mines. Some fine architectural remains (semi-circular arches in bricks of rock-salt, some of them perhaps belonging to the mosque referred to by Ibn Batuta) were examined and much evidence gathered, including painted Moroccan earthenware, copper objects, textiles, ancient glass trinkets with welded wires, beads, etc.

*Ethnology*.—Without being able to refer to everything properly covered by this heading, I may mention my investigations into the last Saharan traces of the Azzer language (completing the inquiry made by Captain D. Brosset and which I am publishing in collaboration with him), the history of Tichitt, Taüdenit, and the Azawad, the names of the varieties of Mauritanian palms, the *shaduf* of the Saharan oases, the painted arabesques and potteries of Walata, etc. A certain number of poetical texts in dialect will perhaps interest Arabic scholars.

## Note on M. Théodore Monod's Journey

In 1934 M. Théodore Monod undertook a scientific expedition under the patronage of the Musée d'Histoire Naturelle, the Ministère de l'Education Nationale, the Gouvernement-Général de l'Afrique Occidentale Francaise, the Académie des Sciences, the Institut d'Ethnologie, and the Association Francaise pour l'Avancement des Sciences. He returned to France in the course of the summer of 1935 after an absence of fifteen months in the Saharan regions of Mauritania and of the Sudan. Leaving St. Louis at the end of March 1934, M. Monod first made his way to Atar by way of Aleg, Mudjeria, Kasr el Barka, Ujeft, and Tungad. From Atar he reached, in the north, the salt-mines of Idjil and the Kedia massif, in the south-west, the Atlantic coast-line at Nuakshott. He travelled about in the western part of the Adrar, making for Shingeti, whence he radiated to the north, south-west, south-east, east, and north-east, towards Iraïf and Shrerik, El Berbera, Twejmart, and Taria, Wadan and El Beyyed. Leaving the Adrar in July, M. Monod went into the Tagant (Tidjika) and, after a detour towards the south-western

borders of the Adrar (in the Tamga district), made his way to Tamshaket and the Rkiz massif. He then crossed the Awker from south to north and reached the large cliff which marks the northern limit of the Awaker dunes and the steppe country of the Hodh. Following this line eastwards to its end by way of Tichitt, Aratan, El Glatt, Walata, and Nema, he arrived at Timbuktu on October 25 by the northern bank of the Fagibin. He set out again on the 29th with the winter *azalaï* (salt caravan) for Arawan and Taüdenit. From this point, in the company of a detachment of camel corps from the Timetrin, M. Monod visited the ruins of Teghaza for the first time, later joining the winter reconnaissance party of the Arawan section of the camel corps. It was with a section of this unit that M. Monod, after his stay at Taüdenit, was able to visit El Gettara and In Daguber on the fringe of the Tanezruft, and to skirt the cliff of Khnashish from El Gettara to El Kseib (21 December 1934). From El Kseib the detachment made its way to Aguraktem, the water hole discovered by Captain Jayet in 1928 and revisited in 1933 by the Sudanese and Algerian camel corps; it then proceeded to the Hank, crossed to the north of Tagujalet and worked up towards the north-east as far as Shegga (21 January 1935), the most northerly point yet reached by a French Sudanese military detachment. The return from the Hank to Aguraktem took place by way of Tufurine and Teghaza, where M. Monod completed the observations which he began in the previous December. This was the first time that the salt-mine of Tiniulig, touched that winter by three Meharist detachments, had been visited by Europeans. Prior to resuming the direct road to Arawan, M. Monod and Captain Gufflet also made a rapid reconnaissance of the Tiniulig–Aguelt el Melha–Bir Amran–Mjebir–Tiniulig route. Finally, a journey of about 600 km. across the unknown southern part of the Erg Shech and of Miraiye, covered in a fortnight, brought the little party back to the post at Arawan on 16 March 1935.

M. Monod was obliged for the time being at any rate to give up the crossing of the Tanezruft from the south-west to the north-east. But he proceeded to the western edge of the Adrar of the Ifoghas in order to study the site where the skeleton of the fossil man of Asselar had been discovered by him, in company with M. Besnard, in 1927. The journey from Arawan to Asselar was made by way of Guir, El Mraiti, Mabruk, and the Timetrin. The explorer returned to Timbuktu on 11 May 1935 by Abelbodh, Arezzaf, Urozil, and the massif of Tadrart. The area covered by M. Monod measures 1750 km. from west to east (from the Atlantic coast-line to the Adrar of the Ifoghas), and 900 km. from north to south (from the Hank to Timbuktu). His itineraries exceeded 5000 km. He collected more than 10,000 specimens and made a considerable number of drawings, panoramic sketches, plans, geological sections, photographic negatives, etc. As M. Monod has worked continuously in regions rarely surveyed and even hitherto unknown, his work represents a substantial contribution to the scientific knowledge of the western Sahara. Since writing these notes and leaving them in the hands of a friend for publication, M. Monod has accomplished another journey, from which he has just returned.

Most of the place-names have been left in the French spelling of Arabic.

F. R. R.

## ORDNANCE SURVEY DEPARTMENTAL COMMITTEE

IN the Discussion on Ordnance Survey Maps which was opened by the President at the Afternoon Meeting of 9 December 1935 (printed in the *Journal* for April 1936) there was mention of the Ordnance Survey Departmental Committee which had been appointed by the Minister of Agriculture and Fisheries to review the work of the Survey and to make recommendations for its future. This Society having been invited to submit evidence to the Departmental Committee, the President appointed a Committee to advise the Council, and their recommendations on the evidence to be given were approved by the Council on 3 February 1936. With the permission of the Chairman of the Departmental Committee this memorandum of evidence is now published for the information of Fellows.

## ORDNANCE SURVEY DEPARTMENTAL COMMITTEE: MEMORANDUM OF EVIDENCE FROM THE ROYAL GEOGRAPHICAL SOCIETY

*Reference* (*a*) *To consider what measures are necessary to accelerate the revision of the Ordnance Survey maps in order to bring them up to date and thereafter to maintain them at a high level of accuracy, while providing for such other public services as are undertaken by the Ordnance Survey Department.*

### *Revision of Large-Scale Maps:* 1/2500 *and* 1/10,560

It is common knowledge that the revision of the large-scale O.S. maps is now very much in arrear, and that it is urgently necessary to bring them up to date as early as possible. The official period for revision of the present 1/2500 plans is too long for conditions of rapid development around the larger cities. It is understood however that the original method of systematic revision sheet by sheet over the whole country is now in abeyance, and that current revision is confined to rapidly changing areas.

Brigadier Jack has suggested that as the revision of selected areas is completed on the present system, revisers should be left in such areas to carry on continuous revision, so that there should be a record copy of the 25-inch always up to date, and new editions in small numbers could be printed off promptly whenever they were required. We endorse these suggestions.

Complete revision of the small-scale maps should be carried out, at present independent of the large-scale maps, every fifteen years or more often at the discretion of the Director-General, O.S.

### *Research*

It is evident that if the Ordnance Survey Maps are to be brought up to date in reasonable time there must be a large expenditure of public money, and all modern experience shows that in such a case it is a real economy to devote a certain small part of the whole outlay to carefully organized research for the development of new methods and especially of new apparatus, as for

precise photographic survey. There is not at present in Great Britain any establishment, either official or private, which is equipped to plot precise photographic surveys with accurate contours, either on large or small scales, either by ground or air methods. Conspicuous improvements in the design of recent British survey instruments have been due to the Admiralty Research Department, which works in close collaboration with the National Physical Laboratory at Teddington. The R.G.S. submits for the consideration of the Departmental Committee that it should examine the desirability of establishing a similar small department for continuous research in instruments and methods of survey.

In particular, the subject of precise stereographic survey has been greatly neglected in this country. The Arundel Method developed by the Air Survey Committee does well for the purpose for which it was designed, but has no pretensions to accuracy in contouring. Any photographs taken by British surveyors with the photo-theodolite have to go abroad for plotting.

Stereographic survey would be invaluable in contouring the mountain areas in Great Britain. For mapping in the British Empire generally stereographic survey by oblique air photographs has quite untried possibilities. The remarkable success of its use on the East coast of Greenland by the Danish Geodetic Institute encourages us to study seriously its suitability for the British Dominions.

The first duty of the proposed research department might be, then, to establish in England one or more of the most successful Continental models of stereo-plotting machines, and to undertake a serious trial of them, based upon the wide experience now available from other countries. There has been a tendency in this matter to say that if ever the method is to be employed in Great Britain it must be with machines designed and made in this country. This seems to be a distorted application of a good general principle. The facts are that several Continental constructors have brought these elaborate machines to something like perfection at an immense cost in research and experiment. It would be entirely wasteful of us to refuse to profit by their expensive experience, and to spend more money in overcoming the same initial difficulties. Starting far behind, we should not be too proud to get what advantage we can from that situation.

A central research laboratory, such as is here suggested, would benefit the whole British Dominions. The scientific advantages are clear: and it would seem that there should also be economic advantages in a central pool of trained personnel and tried equipment.

*Reference* (*c*) "*To review the scales and styles of Ordnance Survey maps placed on sale to the public and to recommend whether any changes are desirable.*"

*Scales and Grid*

No change in the scales or grid of existing British maps is recommended.

*Representation of Relief*

The new Fifth (Relief) Edition of the 1-inch map is considered by many, probably by the majority of those who use it, to be the most beautiful topo-

graphical map published by any country in the world; and for those who do not like it there is the alternative edition in which the relief is shown by contours and spot heights only. The Relief Edition uses two new principles: layer-colouring so delicately graded that it is only a gradual deepening of colour on the higher ground, with no conspicuous step at the contour; and hill-shading both vertical and oblique obtained by transfers from the old hachure plates of the original 1-inch engraved on copper. The map is therefore both layer-coloured and hachured, yet not obviously so. The layer colours do not give the usual false effect of terraced slopes; the hachures do not obscure the detail of the black plate, as they tended to do even on the older maps in which they were printed in brown; and the combination of vertical and oblique shading gives an effect of modelling which can be obtained in no other way.

Presumably the hachure plates cannot be used to make the hill-shading plates for scales smaller than the 1-inch, since they are not used on the new $\frac{1}{2}$-inch of Greater London, which has the same double shading from drawn shading plates; but the appearance of this map makes one hope that the same plan of subdued layer-colouring and double hill-shading is to be extended to the $\frac{1}{2}$-inch maps as they are revised.

The type of layer-colouring on the $\frac{1}{4}$-inch map is satisfactory.

*Lettering*

The new alphabets of the Ordnance Survey are generally admired, and the lower-case Roman and the Italic could hardly be bettered. The Roman capitals were originally perhaps a little light in weight, looking as if they had been drawn for a less reduction than 2 to 1. A very slight increase in weight has on some later sheets improved them. There seems to be a tendency to draw the names in other characters, Antiquities, Railway Stations, unnecessarily large.

But the type which has recently been chosen for stamping names on the 25-inch plans should perhaps be reconsidered. It is a fount of no family cut towards the end of the last century, before the beginning of the late reformation in printer's type, and has nothing to commend it. Several distinguished founts of the present day are far more like the new-drawn alphabets of the Survey, and would look much more in keeping with the drawn maps.

The beautifully finished lettering on the O.S. drawn maps can be obtained only by building up the letters in outline and filling in the heavier strokes, at the rate of something like fifteen names a day. Names stamped from printer's type are used as an alternative on the larger-scale maps, but typed names never fit the detail properly. The proposed expansion of the drawing-office strength at the O.S. will entail training a great number of new draughtsmen. It will be worth considering if the 1/2500 should be drawn with quill-written names.

*Roads*

The minor roads on the 1-inch and $\frac{1}{2}$-inch require strengthening, and a distinction should be made between arterial and other first-class roads.

*Waterways*

In a recent discussion two students of inland navigation called attention to the neglect of waterways, and a certain carelessness or ignorance of draughtsmen in reducing to the smaller scale what was shown correctly on the 6-inch scale. It was clear that the surveyors had no knowledge of the many interesting features of the fen drainage, and largely neglected to show, or showed wrongly, the essential features of the system: sluices, pumping stations, etc. It was equally clear that the draughtsmen of the 1-inch map were careless of the significance of sluices and locks, often showing the fall of level the wrong way round.

The Director-General has already agreed that the Survey shall give more attention to this question of waterways, which is of special interest at the present time, when water transport and the enjoyment of inland waterways are both growing.

*Antiquities*

The special attention paid at present to the correct representation of Antiquities on the maps of the Ordnance Survey is admirable, but seems to be leading in some cases to displacement of important names and features of the landscape.

# REVIEWS

## EUROPE

ISLANDS VÖLKERRECHTLICHE STELLUNG. By RAGNAR LUNDBORG. (Internationalrechtliche Abhandlungen. Edited by HERBERT KRAUS. Abh. 25.) *Berlin-Grunewald: Verlag für Staatswissenschaften und Geschichte* 1934. $9\frac{1}{2} \times 6\frac{1}{2}$ *inches;* viii + 134 *pages. M.*11

The author of this work is a well-known Swedish writer on international law, who has made Icelandic international relations his speciality. In this recently published work he first gives a brief survey of the development of Icelandic public law, from the foundations of the Icelandic state in 930, during the republican period, as represented by the code of laws called Grágás, down to the fall of the republic and the introduction of the new law books 'Járnsíða' and 'Jónsbók' (1271 and 1280). Dr. Lundborg maintains that the Icelanders considered their country as a sovereign state, even after the Union with Norway, and that they understood and interpreted their redeemable treaty with Norway ("The old treaty," Icel. *Gamli sáttmáli*) accordingly. He also considers it proven that Greenland, discovered and colonized from Iceland about 981, has formed a part of the Icelandic state, that Icelandic laws were in force there, and that *Gamli sáttmáli* also comprised that country. In this he follows the opinion of the greatest authority on Icelandic law, the late Dr. V. Finsen (editor of *Grágás*, Judge in the Supreme Court of Denmark), whose opinion on this point has been accepted by several eminent scholars.

Dr. Lundborg then describes the later development of Iceland's international relations under her Norwegian and Danish Kings. Of special interest is the introduction of the absolute monarchy in 1662, two years later than in Denmark and Norway, and the Icelandic Act differing somewhat from the Norwegian and Danish. A royal counter-promise was given that Iceland was to keep intact her old laws and institutions, and this promise was kept. But gradually the royal power became more prominent and at last the opinion prevailed that the supreme power of the state belonged exclusively to the absolute King. In 1800 the Althing was temporarily abolished. It was re-established in 1845, as a consultative assembly, but already in 1848 it began a struggle for regaining its legislative powers. In 1848 constitutional monarchy was introduced in Denmark, but in Iceland the king remained absolute. This of course caused a conflict between the Althing and the Danish ministers responsible to the Parliament (*Rigsdag*) of that country, who considered themselves entitled to exercise the royal powers in Iceland on behalf of the king, even though no Danish king had legally altered the previous political relations between the two countries—even the *Gamli sáttmáli* had been acknowledged by the Government in 1768 and 1774. At last the Danish Rigsdag passed an Act (2 January 1871) on the status of Iceland in the Kingdom of Denmark, but the Icelandic Althing at once protested against the validity of this one-sided and purely Danish law. Dr. Lundborg then describes the later phases of Iceland's struggle for the recognition of her independence and rights as a sovereign state. He maintains that in the proposals of the Danish-Icelandic Parliamentary Commission of 1908 there was a recognition of Iceland as a sovereign state in actual union with Denmark. The Althing however considered that this was not quite clearly expressed, and the proposals of the commission were rejected. In 1904 the residence of the responsible minister for Iceland had been transferred from Copenhagen to Iceland, and an Icelander, Hannes Hafstein, had been appointed minister.

Dr. Lundborg shows how gradually the Althing and the Minister extended their powers very greatly. In 1917 it became apparent that Iceland intended to settle its affairs single-handed. This caused an alteration in the attitude of Denmark. The Danish Government offered to negotiate and sent delegates to Reykjavík. Dr. Lundborg maintains that by this action Denmark recognized Iceland as a sovereign state. Here it is important to note that neither before this act of recognition nor at the time of the formal recognition by Denmark, 1 December 1918, did Iceland issue any special declaration of sovereignty, as it was considered that the sovereignty of the country had been fully established by the foundation of the Icelandic commonwealth in 930, and that it never had been lost in any subsequent period.

Dr. Lundborg concludes: *de jure* Iceland has been a sovereign state through all this period, but *in re* the country has not been so. The first assertion is duly proved. The last may be questioned. The last chapter of the book contains a commentary on the Danish-Icelandic Act of Federation of 1918. Dr. Lundborg maintains that the Union between Iceland and Denmark is really rather an alliance (*Staatenallianz*) than a federation. This work of Dr. Lundborg's is in my opinion his best. It contains much new material, and it is written with great fairness and acumen. It is the best book on this subject that has so far appeared. J. D.

## ASIA

LE DOAB DU GANGE ET DE LA JAMNA. By R. N. Dubey. *Paris: Librairie Picart* 1935. 10×6½ *inches; 176 pages; illustrations and maps*

The term *doāb*, meaning the land between "two waters," is applied in India to many tracts lying between two rivers. The area between the Ganges in its upper course and its tributary, the Jumna, stretching from the foot of the Siwalik Hills southwards and south-eastwards to the confluence of the rivers at Allahabad, is the Doab *par excellence*. It is an area full of historical, religious, and cultural associations; but of these the volume before us does not treat. Forming geologically part of the upper Gangetic alluvial plain, the soil is generally fertile, and the population accordingly dense (518 to the square mile). As the majority of the population depend for their livelihood upon the cultivation of the soil, the conditions affecting agricultural operations are of primary importance; hence Dr. Dubey devotes most attention to such matters as soils, rainfall, crops and their cultivation, live stock, and means of irrigation. Though the annual rainfall over the area, which varies from less than 20 inches in a portion of the Muttra district to about 45 inches in the north of the Saharanpur district below the Siwaliks, is less than in other great agricultural regions of northern and eastern India, the Doab is fortunate in possessing two important systems of canals, with their branches and distributaries. These are the Upper Ganges Canal, designed and started by Sir Proby Cautley nearly a hundred years ago, the first original irrigation scheme of any magnitude carried out in northern India, which serves the northern and central districts, and the Lower Ganges Canal, taking off at Naraura in the Bulandshahr district, which feeds the seven southern districts. Owing to private and official enterprise moreover within the past seventy years several important industries, chiefly concerned with cotton and wool, leather, dairy farming, oil-pressing, and sugar-refining, have been successively developed on modern lines, the principal industrial centres being Cawnpore, Agra, Aligarh, and Meerut.

The author has given a survey, supplemented by numerous statistics, of the agricultural and industrial occupations of the people, indicating many of the

problems that present themselves for improvement and development. The information furnished has been carefully compiled from reliable sources. The absence of an index and, more particularly, of a clear map showing the geographical features of the country included in the Doab and the places mentioned, must however be noted, as also the many typographical errors in the bibliography at the end of the volume. C. E. A. W. O.

CHINA: A Short Cultural History. By C. P. FITZGERALD. (The Cresset Historical Series: Edited by C. G. Seligman.) *London: The Cresset Press* 1935. 10×6 *inches;* xviii+616 *pages; illustrations and maps.* 30*s*

The introduction to this book is a valuable summary of facts under the general heading "the Land and the People." The first section of the book naturally deals with Feudal China from the times of prehistory and speculation down to the art of the Shang and Chou dynasties. It is here perhaps that one looks for the greatest caution, since the numerous discoveries by excavation in China in the last twenty years have demonstrated the folly of an arrogantly dogmatic attitude about China's early dynasties. Mr. Fitzgerald is, here and there, a little too sure that the future will throw no further light upon the past and shows himself a little eager in "debunking" the past. None the less this first section will thrill many of its readers with its straightforward account of Chinese cultural achievement in the earliest days. The inquisitive reader might ask why Fig. 6 (with the caption "Ceremonial Hand Plough, Japan"), should have been used to illustrate an early Chinese ritual. The provenance of the picture may be Japanese but the thing itself is the Chinese Lei-Ssŭ and was borrowed by the islanders long centuries later. It is indeed the earliest form of hand plough known and was used by the Emperor to turn the first clods of the first furrow of the year.

With the next period ("the First Empire") the author feels himself on firmer ground, and after discussing the formation of a centralized State and the social and economic revolution, we arrive at Han Imperialism and the discovery of the West, literature and religion in the Han Dynasty and the art of the period.

Brief sketches of Taoism and Buddhism and their unquestioned influence upon the intellectual and artistic life of the people lead naturally on to an account of the T'ang Empire, perhaps the Golden Age of Chinese history. The Sung Dynasty has its tale also very little less renowned, and by the time Part VI is reached the reader is in a position to put the much-vaunted Ming Dynasty in its proper place. All too many writers in the past have summarized the earlier epochs of Chinese history in one chapter and then filled up innumerable others with more or less accurate discussions of art forms, objects, shapes, and lines of potters and artists of the Ming Dynasty. The last chapter of this very valuable guide to Chinese cultural history, is given to a discussion of China under the Manchus, bringing the work down to the beginning of the Republic. The author nowhere seems to show himself unduly devoted to any particular period; indeed, he views Chinese culture throughout objectively and provokes the reader to think for himself. Those readers who have read other works will find themselves in disagreement with Mr. Fitzgerald here and there; and this is all to the good as it will make for further investigation. All aspects of Chinese artistic and pragmatic effort are dealt with (there is a special chapter on the Golden Age of Poetry), and perhaps only the specialist will complain that there is not enough on his special subject.

The work is well documented and it is impossible to speak too highly of the numerous illustrations and the very clear maps, which add so greatly to the understanding of the text. N. W.

## AFRICA

ZAMBESI CAMP FIRES. By ROBERT SUTHERLAND. *London: H. F. and G. Witherby* 1935. 9×5½ *inches;* 228 *pages; illustrations.* 10*s* 6*d*

This book seems to be intended as a guide to intending big-game hunters. The first four chapters are entirely devoted to advice to those preparing their first hunting trip, and to their subsequent conduct when in the field. Much of this advice is very sound, but there are points with which all would not agree, such as never using safety-catches on rifles and guns. According to the author's code it is better to risk shooting one's companion in the back than to risk forgetting to take off the safety-catch when in a difficult position with a dangerous animal.

It is unfortunate that hippopotamus-hunting is spoken of as giving "a real thrill," or that an attempt to shoot a giraffe is even mentioned; nevertheless there are a number of amusing as well as exciting incidents which will render the book interesting to those who have yet to experience their first journey in Africa. From the last chapter it seems that much of the material is taken from incidents of many years ago, so that what appears at first to be the author's rather tardy admission that he has outgrown the lust to kill too frequently may perhaps be forgiven. There are seventeen very excellent photographs of the country and its animals, but no map. V. E. F.

EMPTY HIGHWAYS: Ten Thousand Miles by Road and Lake through East and Central Africa. By R. O. PEARSE. *Edinburgh and London: William Blackwood & Sons* 1935. 8×5½ *inches;* xii+300 *pages; illustrations and sketch-map.* 12*s* 6*d*

This little book is a record of a journey undertaken by a young South African schoolmaster and his wife and it takes the form of a series of letters written to his father, and as he states in his preface, they are obviously published as written and are very vivid.

Academic geographers will learn little from this chronicle; it is a diary of day-to-day events and impressions set down in a spontaneous and light-hearted way which will appeal to many who wish to obtain a picture of the countries traversed. It is not to be expected that on such a hurried tour the writer could have gathered precise information which would enable him to speak with authority on the political trend of the countries visited; but his comparisons of the various educational systems encountered on the tour are worthy of consideration, for he is then on familiar ground, and they exhibit some insight. The frequent chats of the travellers with colonists, officials, and missionaries on a variety of topics often give food for thought. In such a long journey they naturally met with many vicissitudes, but unpleasant experiences were always faced with good humour, for the trip was evidently the great adventure of their lives. Truly the car has revolutionized life in Africa and for black as well as white. C. W. H.

THE FOLKLORE OF MOROCCO. By FRANÇOISE LEGEY. Translated from the French by LUCY HOTZ. *London: George Allen and Unwin* 1935. 9×5½ *inches;* 278 *pages; illustrations.* 12*s* 6*d*

Dr. Legey has worked for many years in Morocco, first before the French occupation and afterwards as one of the doctors attached to the *Assistance Publique* and as head of the Hospital for Women and Children at Marrakesh. In this work she has had unique opportunities for collecting the folk practices of every class of people; and the best index of the sympathy she has won among them is the intimacy of the detail she can document. Probably no one but a trusted doctor could have collected so much. She professes to be an apprentice

in folklore; and her modesty has the excellent result in this book that the facts about practice and belief are stated without comment of any kind, no explanation is attempted of their origins, and no generalized conclusions are drawn. The facts are arranged according to the system of Sebillot.

The earlier chapters on cosmological beliefs conform generally to familiar types, deriving from the Koran with analogies to the Bible. At the creation of human beings the genii too were created, and it is the localized genii who have the greatest influence on human fortune. "The earth is the abode of the genii, but they are specially fond of desert places, of drains, of lavatories, and ruins, and cemeteries." They are particularly dangerous in the night but harmless in the month of Ramadan. At every important stage of life—especially after birth—the genii must be propitiated. On the seventh day from a child's birth, after the sacrifice of a sheep and a ceremonial lustration, it is carried in solemn procession round the house, and as the procession starts the mother "bares her breast, and squeezes out a few drops of her milk and lets them fall on the ground as an offering to the genii, saying as she does so, 'Guests of God, behold our child. Do not hurt it, we do not wish to hurt yours.'" So closely are the genii associated with a house that at its building no one must walk in his shoes on the unfinished walls, and when the house is inhabited parts of the wall are crumbled off and offered to them.

The lore is most remarkable in the variety of its charms; if one fails there are many others to resort to: if the particular charms are no good an all-inclusive one may be successful. "To take oxide of copper, laurel leaves, black pepper, a frog's liver, the brain of a mouse or a pig, some tar, some soot from seven chimneys, and a little earth from a prison" is only one of the many recipes open to a jealous woman: she must rub the mixture on the shoes of her husband and rival. Dr. Legey's book is fullest and most interesting in dealing with the social and family life of women, on the dangerous frontier where superstition and medicine meet. H. H.

A HISTORY OF ABYSSINIA. By A. H. M. JONES and ELIZABETH MONROE. *Oxford: Clarendon Press* 1935. 7½×5 *inches;* viii+188 *pages; illustrations and maps. 6s*

The history of Abyssinia is an outstanding example of Professor Trevelyan's contention that all history is governed by geography. It is essentially the story of the survival of a culture which, but for the geographical nature of the country, would have been swamped. Two factors have contributed to this survival; isolation from the rest of the world, a condition which has tended to unite the peoples of Abyssinia in a common distrust of foreigners; and the number of natural fortresses within the mountainous interior of the country. The former has saved the country as a whole from succumbing to the incursions of invading powers; and the latter, in the dark ages when there were many kings within the empire all claiming the title of Emperor, has prevented the rival armies from exterminating each other in civil war. The legend of Solomon and the Queen of Sheba is still believed and therein lies the greatest strength of the country: identification of church and state in the person of Solomon's descendant. Though the emperors have never actually combined kingship and priesthood, as Prester John was believed to have done by the mediaeval exponents of the legend, there has always been the closest co-operation between the Emperor and the Abuna.

Mr. Jones and Miss Elizabeth Monroe have shown great skill in the selection and presentation of their material. It is the great advantage of this short history that it gives the reader an extremely clear picture of the structure of the story

in which the main events are embodied. Mr. Jones has dealt with the legendary and historical origins of the country, giving enough ethnological and geographical information to explain what follows without reference to maps or glossaries. He covers the history from the beginning right down to the collapse of the monarchy at the end of the eighteenth century. In part five Miss Monroe describes the resurrection of the monarchy and the growth during the nineteenth century of the relations between Abyssinia and foreign powers; finally she leads up to the present dispute with Italy, which is discussed with admirable impartiality and clarity in a separate section. Unlike some historical works which claim to be concise this one leaves the reader with a mental pattern which has colour as well as form. It is this colour that suggests the contrast between the historical Abyssinia, a packed record of the doings of the Lions of Judah, and the less splendid Abyssinia which has existed for hundreds of years without leaving any trace. J. B.

UGANDA. By H. B. THOMAS and ROBERT SCOTT. Published by authority of the Government of the Uganda Protectorate. *London: Oxford University Press* 1935. 9×5½ *inches;* xx+560 *pages; illustrations and maps.* 15*s*

It is not quite clear how far the authors of this book are authors and how far compilers, but whichever be their principal function the work is one which reflects great credit on themselves and their collaborators, and, we may add, the Colonial Service to which they belong. It admirably fulfils the object of its production as set out by Sir Bernard Bourdillon in his introduction—namely to provide a publication which will bring together the dry bones of hard fact to be found in official reports, will "clothe them with flesh and present a reasonably complete picture of a Uganda that is very much alive." At the same time they have not confined themselves to present-day facts; the bearing of past history and past influence is ever present to their minds, and the work is pervaded throughout by evidence that ample use has been made of the very full and complete bibliography contained in Appendix I and referred to in chapter XXX. It is not too much to say that the enquirer on any aspect of Uganda present or past (so far as that past is known) can either find in this book the enlightenment he requires or learn readily where it may be found. Many handbooks dealing with British Colonial Dependencies have appeared; the more recent productions of this nature have exhibited a steadily increasing merit in literary skill, breadth of presentation and readability, and we think that this volume represents the high-water mark so far attained.

Great Britain assumed a Protectorate over Uganda in April 1894. In that year the total trade of the infantile Protectorate with the outside world, as recorded in chapter XXIII, was about ten thousand pounds; in 1934 it was nearly five and a half million pounds, and in 1929, a year of exceptionally high prices, actually reached six and a half million pounds. This material progress has been accompanied inevitably by developments, social, economic, political and administrative, which are concisely, intelligibly, and on the whole very impartially depicted. Space does not permit us to make even a passing allusion to more than a few of the thirty chapters into which the work is divided. They commence with a historical retrospect the authenticated facts of which are almost non-existent before the arrival in Uganda of Speke in January 1862—at which date, one may reflect, Lord Lugard, who contributes a characteristically modest Foreword, was celebrating his fourth birthday. The next chapter deals with the physical geography of the country, and the third, entitled the "Geological Background," we should choose as the most informative and striking in the book, especially to the multitude of readers who are not yet familiar with

the results of the researches of Dr. Wayland and Dr. Leakey. The correlation of glacial periods with pluvial periods in equatorial regions, and with primitive man, is full of interest. The fact that early man was already in the country at the beginning of the "slow and continuous" depression ending in the formation of the Lake Albert Rift, will be new to many. The fact that it is only comparatively recently that the river-system ceased to be connected with the Congo Basin helps to account for the essentially West African fauna and flora found to-day to the east of the Albertine Rift. Uganda, like India and most of Africa, had no bronze age. Unlike most of tropical Africa however it contains no evidence of any true Neolithic period, and this is probably due to its inaccessibility (especially after the formation of the Western Rift) affording no channels for the diffusion of this culture. One of the interpluvial periods described in this chapter which caused the dwindling or drying up of lakes was no doubt responsible for the disappearance of the crocodile from Lake Edward—referred to on p. 189. Physical obstacles of much later date are also responsible for the absence of the rhinoceros from Uganda proper, and we know of no evidence to support the statement on p. 385 in the very interesting chapter (XXVI) on game and hunting that less than a hundred years ago Black Rhinoceros were probably generally distributed in the area south and west of the Victoria Nile and north of the Kagera River.

The volume is produced with the degree of excellence which we expect from the Oxford University Press. The revision has evidently been most careful: in the course of a careful perusal we have observed only one typographical error—on p. 201, where the name Theiler has been transmuted to Sheiler. The maps give all the information needed for easy reference in a work of this kind to supplement the letterpress, and the illustrations (from photographs) are well chosen and well reproduced. Those which depict types of Uganda scenery, notably Mount Ruwenzori, the lakes, and the Murchison Falls, are especially attractive. The first prize, we think, is deserved by the picture of Lake Mutanda facing p. 34. W. F. G.

KENYA: the Land of Illusion. By LADY EVELYN COBBOLD. *London: John Murray* 1935. 9×5½ *inches;* x+236 *pages; illustrations and map.* 10*s* 6*d*

This is a light and amusing book that succeeds in giving a fair picture of many aspects of Kenya Colony. It is perhaps unavoidable that in this "elaborated diary" there appear so many personalities scarcely connected with the theme. Possibly the mention of some of them will provide amusement for others concerning the sources from which the author obtained her remarkably complete collection of Kenya tall stories. Unfortunately like most books that are written after a brief visit to a country, it abounds in inaccuracies that are irritating to any one familiar with the subject; thus 2-ton crocodiles and Vavirunda Cranes, let alone Spirillent Ticks, are never met with by the normal traveller. Had the proofs been read by some one with a knowledge of the country a great many mistakes would have been avoided.

Nevertheless there is in this volume much about Kenya to amuse and interest, besides a brief glimpse of air travel in the course of the journeys to and from London. The book is illustrated with twenty-two good plates and a poor map. V. E. F.

THE VOICE OF ATLAS: In Search of Music in Morocco. By PHILIP THORNTON. *London: Alexander Maclehose and Co.* 1936. 9×5½ *inches;* xii+226 *pages; illustrations and sketch-map.* 8*s* 6*d*

This is a book about Morocco by one who has lived intimately with Moors, Berbers, and Jews; can speak Arabic, and even some dialects; has been treated

successfully by native doctors and magicians when French doctors had failed; who can play three or four Arabic instruments, and is a qualified snake-charmer. Mr. Thornton has obviously a flair for Arabic ways of thought and life, which he plainly, and with no pretentiousness, finds sympathetic and natural. He has a way of gaining the confidence of the most naturally exclusive and hostile people, and with this gift he probably saw, heard, and learnt more about Moroccan music and dancing than any European has ever done before. This study of Moroccan music is the more impressive, because the author can quote parallel instances of chants, hymns, *maqamat*, and the like which he has heard in Albania, Yugoslavia, Romania, and Turkey. Music apart even, he has written a fascinating travel-book, with some interesting photographs and a tolerable route-map. M. C.

## NORTH AMERICA

THE DISCOVERY OF THE OREGON TRAIL. Robert Stuart's Narratives of his overland trip eastward from Astoria in 1812–13; to which is added an Account of the *Tonquin's* Voyage . . . and Wilson Price Hunt's Diary of his overland trip westward to Astoria in 1811–12. Edited by PHILIP ASHTON ROLLINS. *New York—London: Charles Scribner's Sons* 1935. 10×7 *inches;* cxxxviii+392 *pages; maps and portraits.* 31*s* 6*d*

Robert Stuart was the leader of the party which crossed the United States in 1812–13 by the route later known as the "Oregon Trail." Stuart had become a partner in John Jacob Astor's fur venture and, sailing in the *Tonquin* from New York in 1810, had been amongst those who founded Fort Astoria at the mouth of the Columbia River in 1811. The success of the Pacific Fur Company, if it was to compete with its English rival, the North West Company, required the establishment of an overland route to New York. The continent had already been crossed in both directions by Lewis and Clark in 1804–06; and Hunt, a partner of Astor, crossed to Fort Astoria in 1810–12, by a route that was unprofitably devious. The return journey from Fort Astoria to St. Louis was undertaken by Stuart, and is described in the journal and travelling memoranda that Mr. Robbins now publishes.

Stuart's entries are irregular and the spelling eccentric; but the compact and sober style, heightened occasionally by unexpected literary turns of phrase, renders his narrative dramatic: it would be difficult to better the description of McClellan's fight with the Indians, or that of the stampede of the horses at McCoy Creek. The party was reduced at one stage to such straits that Stuart with difficulty stopped them reverting to cannibalism; and the incident is quite baldly related. The tone of the journal is always philosophical, whether the author is discoursing on solitude, on the absence of stays or corsets amongst the Indians, or merely relating that the trap, on which the party depended, had provided them with nothing more than a beaver's paw. There is much information about trees and animals, and about the "furred Race" in which the party was especially interested.

This is the first time that the journal has been printed, although part of the travelling memoranda (which was utilized by Washington Irving) was translated into French and published in 1821. The biographical note and foreword are a monument to the industry of the editor and his assistants, although there are some details—amongst them the seven-page genealogy of the Stuart family—which could with advantage have been omitted. In their place the general reader might welcome more information about the fur trade and the personality of John Jacob Astor; and a résumé of the results attained by those

who preceded and followed Stuart would make it easier to estimate the value of his achievement. The book is well annotated, indexed, and provided with adequate maps. J. P. H. M.

AMÉRIQUE SEPTENTRIONALE. By HENRI BAULIG. Généralités—Canada. (Géographie Universelle. Edited by P. VIDAL DE LA BLACHE and L. GALLOIS. Tome XIII. Première Partie.) *Paris: Armand Colin* 1935. 11½×8 *inches;* 316 *pages; illustrations and maps.* 90 *fr.*

This volume, the thirteenth of the series, is devoted to a general account of North America and to Canada. In a broad way it follows the plan of earlier numbers. It is extremely well produced, is clear in treatment, and gives a useful picture of the areas with which it deals. The account of the continent as a whole is perhaps the more interesting part, and Professor Baulig has treated the great structural and physiographical problems lucidly. In fact one can obtain a clearer view of these problems than is usually the case. The other chapters in the first part deal with the Seas, the Climate, Inland Waters, Vegetation and Fauna, the Indians, Discovery and Colonial Enterprises, and the Peopling of the U.S.A. and Canada on a territorial and historical basis.

Space naturally forbids any great detail, but the author has handled his material well and the reader can easily follow his arguments and lines of thought. The bibliographies at the end of each chapter are not too long, but call attention to the essential literature, so that the student can easily pursue his study in more detail.

The description given of racial and related problems in the continent is full and well set out. Students will be able to get a clear idea of the very mixed make-up of the population of both the States and Canada. Further, it is shown how the several human "types" adapt themselves to one another and to their environment. Naturally the French inhabitants of Canada are stressed to a somewhat greater extent than they might be in an English book, but this is all to the good.

The second part deals with Canada, together with Newfoundland and Alaska, on a regional basis. For the most part each section begins with a description of the structure and is followed, as circumstances permit, by accounts of the life, resources, and industries of the area. Certain sections, *e.g.* the Laurentian Provinces, are treated more fully than are others. But the whole forms a unity, and the author has taken care to point out the effects of the world war and succeeding events on economic and other matters. Mention must also be made of the effect of gold-rushes on the distribution of population and on the growth and decline of certain townships.

One of the finest features of the volume is the excellent series of photographs. These are a real help and give the reader an excellent view of many aspects of the continent. The fact that many are aerial pictures adds considerably to their value. The volume is not indexed, which is a pity, but the contents list is full and reference to places is comparatively easy.

The book should be welcomed by school teachers and others. The treatment is not always full enough for advanced university work, but for higher school work and preliminary studies at a university it seems admirable. J. A. S.

## CENTRAL AND SOUTH AMERICA

THE SPANISH MAIN: Focus of Envy, 1492–1700. By PHILIP AINSWORTH MEANS. *New York and London: Charles Scribner's Sons* 1935. 9½×6½ *inches;* xii+278 *pages; illustrations and maps.* 15*s*

Mr. Means, continuing his studies of American history, has arrived at the intrusion of the Europeans into the Western Hemisphere, and in this book he

concentrates his attention upon their activities and rivalries in the "Spanish Main" during the first two centuries. He interprets for this purpose the Spanish Main as the southern half of the Gulf of Mexico, the Carribean Sea, and the northern portion of South America, and his theme is the establishment of Spanish rule in this area, its rôle as the strategic centre of Spanish dominion in the New World, and the efforts of French, English, and Dutch to secure a share in its wealth, first by buccaneering and contraband trade, and finally by annexation. Throughout the period, despite occasional heavy reverses and the clumsiness of their administrative machinery, the Spaniards remained the dominant power. What this meant for the native races and for the future development of the region the author is of course fully aware, but it would have added to the value of his book if he had developed this aspect and dealt less fully with the incidents of political and military history; perhaps this is reserved for a future volume. It is interesting to note that he now considers that probably 150,000 Spaniards had arrived in the New World by 1574. Unfortunately for the indigenous peoples, these immigrants were actuated by two conflicting motives, the first, to wring as much out of them as possible, principally precious metals; the second, to provide for their spiritual welfare. Mr. Means recognizes this discrepancy, and continually endeavours to vindicate the record of Spain as a colonizing power. It would have made his study of the colonial policies of the European Powers clearer had he distinguished more carefully between the two main systems. He argues that there was a natural area for Spanish development beyond which they failed to establish their rule. He does not emphasize the fact that in the main this natural area was the home of comparatively dense indigenous native populations, upon whom the Spanish in varying degrees imposed their culture. One form of English colonization, in contrast, envisaged the establishment of immigrants on a self-supporting basis, and this is the explanation of the fact, which he notes, that in the Spanish territories there was nothing corresponding to the "frontier" of Anglo-Saxon America. A truer basis for a comparison of English and Spanish colonial policies would be found in British methods in Africa and India. His final judgment is that in relation to native peoples, French rule was more successful than Spanish or English.

As his extensive bibliographies show, Mr. Means has familiarized himself with most of the printed materials available on his subject. His method is to summarize these and then to present his conclusions forcibly and often in colloquial style. Thus, if the reader cannot always accept the judgments, he at least has at his disposal a vivid and concentrated synopsis of the record. One or two minor points are doubtful: in introducing his Navigation Acts, Cromwell was hardly following Spain in a new departure; Drake and Raleigh require to be studied against a wider background than the Spanish Main to be fully appreciated; and there is a curious reference to English climate on p. 173. G. R. C.

## AUSTRALASIA AND PACIFIC

THE SQUATTING AGE IN AUSTRALIA, 1835–1847. By STEPHEN HENRY ROBERTS. *Melbourne: Melbourne University Press, in association with Oxford University Press*, 1935. 9×5½ *inches;* x+456 *pages; map.* 21*s*

This is an expansion of Part III of the author's 'History of Australian Land Settlement,' and deals more fully than was possible in a general survey with the problems of the squatting period. By making full use of available manuscript materials, Professor Roberts has been able to give a complete picture of the years 1835–47: the origins and development of the squatting movement, together with the political history of the colony. So far as the clash between

Wentworth, Lowe, and Sir George Gipps is concerned, he feels that he is compelled to re-interpret their characters. In England however Robert Lowe passed for a politician rather than a statesman, even though he ended as Chancellor of the Exchequer. That Wentworth was a primitive and violent person emerges from any consideration of the facts. Gipps (he was forty-five, not thirty-seven, when he arrived in Australia, p. 122) seems hardly to fill the rôle that Professor Roberts wishes to assign to him. In opposing Wentworth and the squatters, in whose interests was the Governor acting? Transportation was ceasing, but free immigration was also on the decline; gold was yet undiscovered and farming negligible. The squatters were selfish monopolists, but Professor Roberts himself draws an unflattering picture of the other free occupants of the colony. Was Gipps, in seeking to place restrictions on the squatters, really much less blind to the vital interests of Australia than the Home theorists and politicians whom the author so justly ridicules?

There may actually have been little romance in "monotony and mutton fat"—though to judge from the type of men attracted to sheep-farming, this can hardly have been the case—but Professor Roberts is able to give a particularly interesting description of the ordinary squatter's life. The chapters on wool and on the squatters themselves (especially Chapter X, which is based on manuscripts left by squatters) balance those on the constitutional problems, and provide the contrast necessary to complete the picture of colonial life. Professor Roberts writes briskly, even if his style at times leaves something to be desired: parentheses such as "wrote this very young scion of the Derbies" should not be intruded into excerpts from despatches (p. 149); such phrases as "the emotional excoriation of desperately tried souls" need find no place here (p. 147). The maps and index are adequate; there is an excellent selective bibliography, together with a very full description of the manuscript sources used.

J. P. H. M.

AUSTRALIA AND THE FAR EAST: Diplomatic and Trade Relations. Edited by I. CLUNIES ROSS. *Sydney, Australia: Angus and Robertson (London: The Australian Book Co.) in conjunction with The Australian Institute of International Affairs* 1935. 8×5 *inches;* x+310 *pages; maps.* 7*s* 6*d*

The history of Australian political contacts with China and Japan, especially Japan, and of oriental immigration into Australia is recorded by Professor S. H. Roberts and, under his direction, Miss Margot Hentze, both of whom trace, in considerable detail but somewhat apologetically, the gradual crystallization of Australian motives in seeking self-protection against peaceful invasion from Asia. While Australia may be congratulated upon the goodwill that has lately been cultivated in Japan, Professor Roberts' history of the relations between the two countries affords salutary reminders of a number of occasions upon which Australian policy caused much bitterness in Japan. Perhaps the most interesting episode in those relations was the curt rejection by Japan in 1877 of a South Australian plan for systematic colonization of the Northern Territory by all classes of Japanese. In the account of the war-time exchanges concerning Japan's claim to the Marshall and Caroline Islands Professor Roberts leaves much room for controversy, but the conclusion he reaches that, in recent years, trade relations have played an important part in establishing reciprocal feelings of friendliness between Australia and Japan is well founded. He points out, with no little truth that, whereas trade disputes can be kept within bounds, nothing can restrain emotional patriotism when brought into play between peoples of different traditions.

Miss Hentze's survey of "Australia and Oriental Immigration," although less

critical and in greater detail than Professor Roberts' study, is exceedingly well written and most informative. It has about it an air of conviction and the particular merit of dispelling the frequently heard criticism that Australia's restriction policy is "deliberate monopolization of vast tracts of valuable country." Miss Hentze declares that scientific evidence demonstrates conclusively that Australia's size should not be confused with its habitability or its resources with its superficial extent. The concluding pages of this study deal with Australia's policy in relation to tropical Australia and the Mandated Territory of New Guinea. Miss Hentze asks whether Australia's determination to employ only European labour means that many of that continent's tropical possibilities are being neglected instead of exploited. The position is summed up as follows: Although white settlement in the tropics is not barred by climate, conditions generally make it difficult and certainly expensive; that penetration of tropical regions (with certain exceptions) must therefore be gradual and development of tropical possibilities correspondingly slow. Finally, Miss Hentze remarks that the term "White Australia" gives a wrong and unfortunate orientation to the colour element by placing it in the forefront—and that the more non-committal term "immigration policy" would avoid injury to the feelings of oriental peoples and be more in accordance with fact.

Sir Robert Garran's essay on "Diplomatic Relations in the Pacific" refers less to Pacific problems than one would have hoped from a constitutional lawyer of such eminence. Nevertheless such views as are expressed on those problems are temperate and broad-visioned. "The Pacific," he says, "may be the cockpit of war or a ring of nations bound together by ties of goodwill and material self-interest." He is clearly apprehensive lest the multiplicity of diplomatic devices to afford security should obscure the "will to peace" and from his survey of conditions in the Pacific the conclusion emerges that, although the present diplomatic machinery is adequate for immediate needs, an effort should be made to "implement, adapt, develop and improve" it.

Professor A. L. Sadler writes briefly but authoritatively on the "Influence of Japanese Culture and Tradition on Her Foreign Relations," but towards the end of his chapter he rather passes out of the sphere of culture into that of politics.

Dr. E. R. Walker, Lecturer in Economics in the University of Sydney, contributes a brilliant study on the economics of Australia's trade with the East. That study concludes with a re-statement of the fundamental fact that the prospect of increasing trade "depends ultimately upon the degree of cooperation which Australian resources make possible and upon Australia's willingness and the willingness of Eastern countries and of the outside world to place peace and prosperity before self-sufficiency."

The remaining three treatises, which occupy considerable space in the volume, deal with the possible development of Australian markets in Japan, the Netherlands–India, British Malaya, and China. These matters are discussed thoroughly by Dr. I. Clunies Ross and Messrs. J. G. Crawford and H. D. Black. One finds in Mr. Black's excellent study on "China as a Possible Market for Australian Production" rather much detail. For the purpose of this book a concise statement of policy and of the prospects of developing that trade would have been more appropriate. Nevertheless if the study on China loses something by reason of its length and detail it is, in itself, a most valuable contribution.

The authors of the various studies and the sponsors are to be congratulated warmly upon the production of a book that will take a prominent place among noteworthy studies by Australian scholars. 'Australia and the Far East' is an absorbing book and should be read by every one who wants to understand

Australian opinion on the many problems of the Pacific. The book must however be read carefully. An interested reader will find some difficulty in laying it aside.

SÜDSEE: Travels in the South Seas. By HUGO ADOLF BERNATZIK. Translated from the German by VIVIAN OGILVIE. *London: Constable & Co.* 1935. $9\frac{1}{2} \times 6$ *inches;* xvi + 158 *pages; illustrations and sketch-map.* 10*s* 6*d*

This is a popular travel-book, written by an Austrian anthropologist. It is so well translated from the German that one is only occasionally reminded that it is a translation. Two small slips are the writing of flying dog instead of flying fox (or better, fruit-bat) and chalk instead of lime (as an application for the hair). The title of the book is rather misleading, for less than half of it deals with what is ordinarily understood by the South Sea. The Solomons were the only South Sea Islands visited: the rest deals with New Guinea and the East Indies. The book is concerned chiefly with native customs, but it is not very informative and the serious reader does not gain very much from it except from the numerous photographs, which are quite excellent and deserve special praise on account of the difficult conditions for photography. The author occasionally falls into the error of stressing trivial incidents if a little danger is attached to them: a bathe in the vicinity of a shark and similar adventures are not thrilling, especially if they involve (as on p. 136) the use of the first person singular twenty-three times on one page. The author pleads for the rescue of primitive peoples from the danger of white influence, and it is to be wished that all social anthropologists felt as strongly as he does about it, for then something might be done before the study of the customs of primitive man becomes a "dead" subject. Except for the wide separation of many of the photographs from their proper places in the text, the book is well produced, and there appears to be no misprint. Considering the quality of the photographs, the price is low. J. R. B.

PAPUANS OF THE TRANS-FLY. By F. E. WILLIAMS. *Oxford: Clarendon Press* 1936. $9 \times 5\frac{1}{2}$ *inches;* xxxvi + 452 *pages; illustrations and sketch-maps.* 30*s*

No Government can show a better record of native administration than that of Papua. Mr. F. E. Williams is the Government anthropologist. The latest of his works gives the first reasonably complete account of the people living inland between the Fly River and the border of Dutch New Guinea. As is unfortunately so often the case, the anthropologist has arrived at the last moment. The people dealt with in this excellent book have lost much of their old culture. Their ritual is decadent; they no longer fight; iron has completely replaced stone; calico is conspicuous in the photographs. Depopulation has been disastrous. Mr. Williams cannot credit an apparent decrease in one section from 2723 to 683 in eleven years (p. 47), though he admits a "terribly severe" epidemic of pneumonia influenza in 1919. The people constantly refer to what they call the *Marekai* time, the period of white man's influence (p. 125). Mr. Williams cannot see how white influence could cause such cultural collapse as that which has occurred in the marriage exogamy regulations; but depopulation alone is sufficient to upset all such customs, by killing too soon the elders and prospective mates, by causing whole villages and clans to shift or disappear, by establishing a disproportionate sex-mortality.

In reading Mr. Williams' valuable account this decay must be borne in mind. He describes "the life as it is lived" (p. 12), not as it was in pre-*Marekai* days; this is not a primitive society, but a modern one. He considers the people ready to receive a missionary (p. vii) and that one would be a social asset. In this and in many other respects Mr. Williams shows the enlightened practical view

characteristic of Papua, and lacking in many observers who have written about native problems after only superficial study.

The book is well written. Chapter XIV on the Regulation of Conduct is a very valuable contribution, in which it is rightly emphasized that a culture is not a perfectly integrated whole; there is a culture detritus kept in place by tradition and imitation within what he terms the "Sympathy Group." The author's sketches of individual natives demonstrate effectively the range of character variation within a norm of behaviour, though here again one must allow for the greater liberty and laxity in a decadent depopulated society.

Feasts, based on the display of wealth, gift and subsequent repayment, are most important in this culture (pp. 23, 234). Opulence and apparent generosity are probably basic in human nature over a much wider field than has so far been recognized.

One regrets Mr. Williams' opinion (p. 87) that the accurate identification of ritual or totemic animals and plants is not the concern of the anthropologist nor of interest to him; particularly when on the following page he attempts to demonstrate that the Trans-Fly totems are not of any economic importance, though these include a number of unidentified birds, edible aquatic animals, edible fruits, the roofing-bark tree, and a cockatoo that is a principal source of feather ornaments. The hawk looms large in ritual. Bird-of-prey symbolism is world wide, though it has not yet been written about. Native ideas of conception are extraordinarily confused (p. 174) and connected with the eel as in much of Oceania; the fear of male pregnancy (p. 201) is significant. Seasonality is marked, and rain magic becomes correspondingly important and has been fully studied. The data on magic of all sorts and sorcery are particularly full.

This is a book one reads easily and with pleasure. The author is one of those rare people in anthropology who state their own case without attempting to force all the observed facts into one dogma. The introduction by Dr. A. C. Haddon relates the cultures considered in this book to others in New Guinea; it is full of information and ideas. An appendix on Physical Anthropology, by Dr. Dudley Buxton, emphasizes the value of the nasal index in measurement; physical and cultural data remain uncorrelated. T. H. H.

## POLAR REGIONS

TO THE ENDS OF THE EARTH. By FRANCIS K. PEASE. *London: Hurst and Blackett* 1935. 9×5½ *inches;* 284 *pages; illustrations.* 16*s*

Sailors' yarns have always had a charm for the landsman unfamiliar with the sea, and this entertaining book will appeal to many readers who love amazing adventures told with cheery confidence. Mr. Pease sailed as a cadet in the *Discovery* on her first voyage as a Royal Research ship, and as fourth officer in the *William Scoresby* on the same service. Later he visited Swaziland as a trader and then went out to Hudson Bay on a short Arctic trip. He describes his sensations and emotions in the strange scenes of the Falkland Islands Dependencies and elsewhere with the engaging frankness of a schoolboy revelling in all he sees and making a wonderful story of it.

He claims the right of the young to self-expression and he lets us see much of his character and temperament. "Youth," he says, "is everywhere breaking its bonds." But with all sympathy for the spirit of freedom we still think that the bond of accuracy in statements that can easily be verified should be strictly kept if a reader is expected to accept statements for which an author's word is the only bond.

Now on p. 47 Mr. Pease says, "I had the thrill of being present when the

*Discovery* took the deepest sounding that has ever yet been logged. This sounding was seven and a quarter miles deep." The "Discovery Reports" coldly record this sounding as 4500 fathoms, or say 4½ miles. He tells on p. 49 that the name of Deception Island "originates from the old whale captain William Scoresby, who called in there during one of his many whaling expeditions to the Antarctic Continent," but we know that neither William Scoresby, father or son, ever crossed the equator as a whaler. Mr. Pease, on p. 100, tells how he saw a hut on the coast of Graham Land which was erected in 1913 by Sir Ernest Shackleton in the course of his retreat from the *Endurance* sunk in the Weddell Sea; but Shackleton never was on Graham Land and he had not even bought the *Endurance* in 1913. Many similar lapses of memory or care might be cited, least amongst them a misquotation from Browning on p. 141:

> "While a chaffinch sings on the orchard bow
> In England now, in England now."

quite natural, no doubt, for a nostalgic young sailor while a skua screams on the *Scoresby's* bow amidst Antarctic ice.

Duty requires us to warn the reader against too trusting acceptance of these memories of strange happenings afloat and ashore, though taken as travellers' tales they may not be without poetic truth. Some of the illustrations were not taken in the regions visited by the author. H. R. M.

THE ESKIMOS. By KAJ BIRKET-SMITH. Translated from the Danish by W. E. CALVERT and C. DARYLL FORDE. *London: Methuen and Co.* 1936. 9×5½ *inches;* xiv+250 *pages; illustrations and map.* 15*s*

Since Rink began the scientific study of the Eskimo some seventy years ago and was followed by Holm and Boas a great deal has been written on these people and the time was ripe for a comprehensive book. Fortunately this task was undertaken by Mr. Birket-Smith, a Dane who has spent years among the Eskimo and travelled from end to end of their domain. Not only is he a scholar conversant with every aspect of the subject but he shows a happy faculty for lucid exposition combined with a power of condensation that results in a valuable work covering all the ground within the compass of some two hundred pages. And he has succeeded in guiding the unscientific reader through the complexities of such topics as anthropometry and language without sacrificing the value of the book to serious students. Mr. Birket-Smith is cautious about the racial origin of the Eskimo. Probably they are related to primitive "mongoloids" and suggest affinities with the Lagoa Santa type found in various parts of South America. This is the type that suggests links with the Melanesian skulls. High mortality is largely counterbalanced by high birth rate, but nevertheless the Eskimo territory has shrunk. Mr. Birket-Smith suggests deterioration of climate and uplift of the area which makes poorer conditions for sea mammals on which life depends. He touches on the subject of the so-called blonde Eskimo who incidentally were known long before Stefansson's report, and shows that fair hair is due to discoloration and the blue ring round the iris is a pathological result of snowblindness. The book is particularly valuable in discussing the culture in relation to local conditions of climate, food, and shelter. Cultural and anthropological evidence points to the Barren Lands being the original home of the Eskimo. Mr. Birket-Smith agrees with Steensby in making the coast between Hudson Bay and Coronation Gulf the region where the Caribou Eskimo developed their sea-culture. With Steensby he agrees with the spread of this Polar-Eskimo culture east and west, but not to Greenland, and the

return movement from Bering Strait of a Neo-Eskimo culture eastward as far as Greenland including the east coast *via* Cape Farewell. But he departs from Steensby in his belief in a second advance from the interior in the central region of which the last ripples occurred in the eighteenth century. This Eschato-Eskimo culture, which naturally shows similarities with the Palaeo-Eskimo culture, is spreading and its spread is associated with a continued uplift of the area. Mr. Birket-Smith concludes with a most thoughtful discussion of the relations of Eskimo and "whites" and the future of the Danish policy in Greenland. The book is well illustrated and has end-paper maps and a copious bibliography. It will long remain a standard work of Arctic literature.

R. N. R. B.

THE WHITE SEA CANAL: Being an Account of the Construction of the New Canal between the White Sea and the Baltic Sea. Edited by MAXIM GORKY, L. AUERBACH, and S. G. FIRIN. English edition by AMABEL WILLIAMS-ELLIS. *London: John Lane* 1935. 9×5½ *inches;* xviii+356 *pages; illustrations and sketch-map.* 15*s*

The subject of the book, which is remarkable as being the "group" composition of no less than thirty-four authors, is the construction of a big canal joining Lake Onega, and consequently the Baltic, to the White Sea. The book serves no geographical or even technical purpose; but information of this kind may be found scattered through its pages at random; and the painstaking geographer may gain an impression of the climate, the glaciated surface and the sub-arctic forests of Karelia. The canal was constructed in twenty months during 1931–33 by tens of thousands of prisoners of the G.P.U., malefactors as well as political offenders, *kulaks*, and "wreckers," and the main interest of the book is to be found in the description of the methods of education applied in the labour camps, methods which are said to have transformed the professional criminals into enthusiastic workers, and the class enemies into convinced followers of proletarian ideals. The life history of these Chekists and prisoners makes very good reading. It is possible that deeply tinged by communistic ideology as it is, and coloured by the usual communistic catchwords, the book may leave out of the picture some of the darker facets of life in these camps; and the reviewer felt occasionally inclined to go and see for himself whether State Police methods are really so fundamentally different in the different countries, as the introduction to the English edition seems to suggest.

F. L.

## PHYSICAL AND BIOLOGICAL GEOGRAPHY

LAWINEN! Abenteuer und Erfahrung, Erlebnis und Lehre. By WALTHER FLAIG. *Leipzig: F. A. Brockhaus* 1935. 9½×6½ *inches;* 174 *pages; illustrations and maps.* *M.*7.50 (*unbound* 6.30)

Avalanches are not only one of the most impressive sights in alpine regions, but they are equally important for surface conditions and plant and human life. In the Alps their importance has increased enormously during the last few decades owing to the increasing numbers of railways and roads, and more especially on account of the winter sports, which make the tree-less and therefore dangerous slopes the playground of an ever-growing number of more or less experienced ski-runners.

In this book Flaig sets out to give the intelligent ski-mountaineer a better understanding of avalanche conditions, and to help him to minimize the attendant dangers. In its size and scope the book is similar to G. Seligman's article in the *British Ski Club Year Book*, 1934 ("An Examination of Snow

Deposits: Part III, Avalanches"). The author is qualified for his task by many years of mountaineering, ski-ing, and avalanche experience; by critical study of the literature; personal acquaintance with many of the leading experts on snowcraft, and by a vivid style. His main thesis that avalanches are more dependent on weather than on surface conditions is strengthened by the statistics of accidents. In the Great War one extremely heavy snowfall was followed by at least six thousand deaths from avalanches on the Austrian side; probably more soldiers have been killed by avalanches along the Alpine front than by the enemy. Although practical experience of avalanches has long been established by mountain people, it is only during the last few years that the snow conditions governing avalanches have been the subject of systematic study. These investigations have shown that the various types of avalanche do not depend always on the age of the snow deposit, but on its water content. Therefore Flaig makes dry and wet snow the main heading of his classification of avalanches (as for instance Allix in *Geogr. Rev.* XIV, 1924; Seligman in 1934 *Brit. Ski Club Year B.* VII, and in his book on 'Snow Deposits and Ski Fields' (Macmillan 1936) ). With the aid of well-selected and reproduced pictures the author treats the different sub-types of avalanches, their snow and weather conditions, and their movement. "Slab" (*Schneebrett*) avalanches, the most treacherous kind to the ski-runner, are exhaustively treated. "Slab" is a snow crust which has been packed hard, and has a marked discontinuity on its under side. Such slabs are sometimes slightly domed. The explanation adopted by Flaig for this domed surface, expansion by cooling of the snow, is erroneous. Snow does not expand with falling temperature, as he supposes (probably in analogy to fresh water between 4° C. and 0° C. and to sea-ice), but contracts as well as fresh ice. Shorter sections deal with protection against avalanches, preventive as well as curative, and the importance of forests and reforestation is duly stressed. But it is interesting to read that under exceptional conditions (extremely loose "wild" snow) avalanches have flown through woods like a sheet flood. A last chapter contains some practical hints for use in dangerous places and in cases of accident. Flaig's book gives to the geographer a good impression of the variety of snow conditions which may give rise to avalanches, and of the tremendous amount of potential energy stored in snow deposits and transformed by avalanches into cinetical energy. Those who wish to know how to take the best measures for their own or their companions' safety in alpine regions will be satisfied by Flaig's treatise. F. L.

HUMAN ECOLOGY. By J. W. Bews. *London: Oxford University Press* 1935. 9×5½ *inches;* xii+312 *pages.* 15*s*

Professor Bews, with a background of plant ecology, has used his skill as a trained botanist to present a picture of mankind from a slightly new and different angle. The author does not claim that his technique is a new one, for he points out that studies of human ecology were undertaken in the "regional surveys" of Le Play and Geddes and their respective schools. These synecological studies have, as he says, tended to run on lines parallel to the extensive plant ecological survey work and mapping of vegetation communities that was taken up so enthusiastically about the beginning of the present century. Professor Bews would have us study human ecology much on the same lines as animal ecology, that is, from the point of view of what he terms the "fundamental triad," environment—function—organism; but with this difference: it is necessary, before man's active control over his environment can be understood, to study the psychology of man himself, and the relationships between psychology and human ecology.

The author has made a rapid survey of all the known factors which have contributed to make man what he is to-day, wherever he may be. It is a brilliant survey, dealing with environment; heredity and ecology; response to environment; human ecology and psychology; control of the environment and man's culture; ancient man and his ecology, each of which forms a separate chapter each with its own bibliography, which indicates the sources of information, and, as the author remarks, will enable the student interested in any particular point, to follow it up without much trouble. Then follow chapters dealing with the ecology of the food-gatherers; plant cultivators; herdsmen and pastoral nomads; and, finally, a chapter on ecological differentiation and classification, and a chapter devoted to general discussion. Of necessity, in a book of this size, there must be a certain amount of generalization, but on the whole the author has steered a fair and skilful course between generalization and meticulous detail; the account is well balanced, theories are put forward and discussed in a calm and scientific manner.

It would be invidious to single out any particular chapter for special notice, because each provides food for thought and will appeal in various degrees to different readers. But I would like to make one reference to a point of interest to myself. On p. 201, quoting from Hocart, it is stated: "Primitive man regarded the sowing of seeds of plants as a process of impregnating the mother earth by means of a male fertilizing agent which resulted in renewed birth." I suppose I must have learnt this some time in my life, but my early impressions of the native were gained in Uganda amongst Bantu whose staple crops are bananas and sweet potatoes. Bananas, of course, are propagated by suckers taken from the parent stool, whilst sweet potatoes are propagated by cuttings, and the general practice with which I am familiar is to plant two cuttings, for the natives say that unless two are planted in contact together they will not grow to produce potatoes. Cassava is propagated from cuttings singly. All these foods have been introduced into Africa, and represent a method of propagation quite different from the indigenous cultivation by planting seeds. But the point is that the word for "seed," in all the Bantu languages with which I am familiar, is placed in the "N" Class and not in the Class which contains the names of trees and plants, and I have long puzzled over this, because it seemed so obvious that the Bantu must have realized that plants came from seeds, and that seed contained this germ of life. I am grateful to the author for this clue, which explains an implication which had hitherto lacked significance.

In his Introduction General Smuts says: "I have the feeling that this special line of approach is even more promising than would appear at first sight, and that the ecological method in human studies which is here begun may yet prove a most powerful instrument in anthropological and sociological research."

E. B. H.

TECTONIC ESSAYS, mainly Alpine. By E. B. BAILEY. *Oxford: Clarendon Press* 1935. 10×6½ *inches;* xii+200 *pages; illustrations and maps.* 12*s* 6*d*

This very important work may best be described as a history of the development of tectonic ideas. To the younger generation of geologists, to whom most of the basic ideas of tectonics have been presented as proved facts, it may come as a revelation. For those of the older generation who have not made tectonics their special study, it will clear up many obscurities and apparent contradictions. For Professor Bailey does not simply lead his readers along the main road stretching from de Saussure by way of Escher von der Linth to Suess, Bertrand, and Schardt, to name only a few of the outstanding landmarks. He guides them also round the twists in the road and up an occasional blind alley, and so

makes it possible for the first time (for the reviewer at least) to understand the work, for instance, of Rothpletz or Bonney in relation to the general advance. The author seems to have lived over again the mental development of his predecessors, since he can appreciate their silences as well as their words (*e.g.* Suess, p. 54).

The book is hardly suitable for the beginner, since the author can only pause for a moment to explain fundamental conceptions; but to any one past the stage of initiation it is highly readable, with vivid flashes of imagery illuminating a difficult subject. The maps, views, and sections are clear and abundant. Chapter XI stands rather apart from the rest of the work as a summary of the detailed work of Marcel Bertrand in Provence. A. M. D.

THE DREAM IN PRIMITIVE CULTURES. By JACKSON STEWARD LINCOLN. *London: The Cresset Press* [1935]. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xiv + 358 *pages; illustration.* 18*s*

In this comprehensive treatise Dr. Lincoln has examined the available information on the occurrence and significance of dreams among primitive peoples. He opens with a brief historical review of dream interpretation from pre-Christian times down to the work of modern psycho-analysis, indicating the transition from the mystical to the scientific approach to the problem. The latter, he suggests, may profitably be applied to the dreams of primitive peoples. These dreams he classifies into unsought, spontaneous, individual dreams on the one hand and induced, sought, culture pattern dreams on the other, the latter being distinguished by their traditional character and stereotyped form. But he also indicates the part played by culture in determining the manifest content even of individual dreams, the character of which changes profoundly when the native culture is broken down by the impact of an alien civilization. This fact, he points out, bears against the hypothesis of "racial memory." "The cultural images are . . . symbols which vary with different cultures and stand or fall with these" (p. 24).

Having stressed the important part played by culture in determining the content of primitive dreams, he goes on to indicate the reverse relationship—the significance of the dream in culture. This he suggests is largely due to primitive man's overvaluation of fantasy processes, and his supposed failure to distinguish between dreams and reality. This is a statement which is rarely clarified by a description of the precise character of the reality concerned. After all, the sportsman who "dreams a winner" in our own culture cannot be said to attribute reality to the horse which he sees in his dream, except in so far as the dream determines his subsequent conduct in placing his bets, and the so-called "reality" attributed by primitives to their dreams often seems to be of a similar character. The point is not of merely academic interest. To attribute reality to dreams and fantasies argues, as the author points out, a similarity to the mental processes of children and neurotics, but to attribute significance to them is a totally different thing.

In dealing with the significance of the dream in primitive culture, Dr. Lincoln points out its importance among many totemic peoples, the way in which sacrifices are often demanded by gods or ancestors in dreams, and the many cases of the revelation of magical knowledge and special ceremonies in dreams. As a result the author reaches two conclusions: the first is that dreams may play an important part in shaping individual and social behaviour within a given culture pattern, and the second that elements of such a pattern themselves may originate in dreams, or rather that "the dream is . . . an intermediate stage between the initial mental process and the cultural result." The first of

these is more convincingly demonstrated than the second, but they both open up interesting avenues of research. His approach to the interpretation of primitive dreams is Freudian, and it is at this point that the social anthropologist will feel tempted to ask to what extent cultural elements can justifiably be interpreted in psycho-analytic terms, the Oedipus complex, sexual symbolism, and the like. Undoubtedly the basic human motives operative in culture can be traced back in the individual to certain infantile experiences, but does this explanation in terms of origin fully explain their reality and significance? To employ an analogy, the pleasure derived from playing the piano could probably be traced back to the infant's joy in making a noise by manipulating its rattle, but should we therefore be justified in speaking of a grand piano as a "rattle-symbol"? If this argument were applied to the more significant human activities, we might be driven to the conclusion that subsequent cultural elaborations of the primitive drives (for example, love and hate in the Oedipus complex) are quite as significant as their substratum of infantile experience.

The book is well documented and contains much concrete material, particularly in regard to North American Indian dreams. Professor C. G. Seligman, in a valuable methodological introduction, points out that Dr. Lincoln's book represents an attempt to co-ordinate the researches of psychologists and social anthropologists. The positive value of such an approach emerges from the study. But so do its pitfalls, for Dr. Lincoln is inclined to stress the role of human motives in determining culture at the expense of the reverse relationship. But this does not minimize his positive contribution towards the solution of a difficult but fascinating problem, a problem which no anthropologist of the future can afford to ignore. R. P.

## ECONOMIC AND HISTORICAL GEOGRAPHY

FUNDAMENTALS OF ECONOMIC GEOGRAPHY. By NELS A. BENGTSON and WILLEM VAN ROYEN. *New York: Prentice-Hall* 1935. $9^{1}/_{2} \times 6$ *inches;* xxviii + 802 *pages; illustrations and maps.* $5.00

The term "fundamentals" in the title might pardonably give the expectation of a critical examination of the methodological implications of economic geography, and the exposition of a systematic body of doctrine. Such an expectation will be disappointed. By "fundamentals" the authors mean a comprehensive course for American university students. They include much that in England would be assumed as covered in other parts of the Geography course. Thus a broad treatment of mathematical geography, of the materials of the Earth's crust, of the weathering processes, of climate and the climatic regions of the world are all included. From the point of view of English readers these sections, comprising over 200 out of a total of 763 pages of text, must be regarded as redundant, and therefore as waste, and yet their inclusion does have the prime advantage of emphasizing that economic geography is not a fraction but an aspect of geography, the whole subject orientated in a particular way. Minerals of direct use to man (sulphur, potash, nitrates, and so on), power, the iron and steel industry, and the principal non-ferrous metals occupy a series of chapters immediately following the treatment of the lithosphere. Agricultural, pastoral, and forest products are taken in connection with the climatic regions of the world, while concluding chapters are devoted mainly to the sea and to manufacturing industries and transport. The emphasis throughout is naturally on the United States, but no major producing area elsewhere is omitted, though sometimes the treatment of such areas is decidedly scant.

It is almost inevitable that when authors cast their net so wide they should

lay themselves open to criticism on points of detail. Some instances may be given. Equatorial forest does not clothe the coast south of the Congo mouth; the oil palm does not need more than 80 inches of rain per year; Tamils rather than Chinese form the labour force of the Malayan plantations, and plantation agriculture is not characteristic of areas of dense population; the "Roaring Forties" are not winds, but latitudes; the term "narrow eastern coast plain of Queensland" is quite misleading; curaçao, except the very cheapest quality, is imported into Curaçao, not exported from it; June 1st–September 1st does not exhaust the growing season at Winnipeg. Apparent misprints are "promeurs" for "primeurs" (p. 481), and 49° F. as the January average for Copenhagen (p. 565). These criticisms are offered in no carping spirit. In a book of this size some errors of fact, emphasis, or interpretation are bound to occur, and in this case they form only minor blemishes. The numerous sketch-maps and diagrams are pertinent and useful, but a very special word of praise must be given to the excellent half-tone illustrations and to the bibliography, which covers a short reading list at the end of each chapter and an extended list in six languages filling nineteen pages at the end of the book. R. O. B.

DE EERSTE SCHIPVAART DER HOLLANDERS NAAR OOST-INDIË, 1595–1597. By J. C. MOLLEMA. Naar de oude Journalen. [*See:* Linschoten-Vereeniging. Deelen VII, XXV and XXXII.] *'s-Gravenhage: Martinus Nijhoff* 1935. 10×6½ *inches;* xvi+366 *pages; illustrations and maps.*

Volumes VII, XXV, and XXXII of the records of the Linschoten-Vereeniging, which appeared in 1915, 1925, and 1929 respectively, are devoted to the account, by the late Drs. G. P. Roufflaer and J. W. Ijzerman, of the first voyage of the Dutch to the East Indies under the leadership of Cornelis de Houtman. The present book, although not actually belonging to the series published by the Linschoten-Vereeniging, was written at the request of that Society and published under its auspices for the benefit of members; and it is a continuation, or more correctly a re-cast and completion, of the work of Roufflaer and Ijzerman, compiled from the Society's records and the abundant material collected by Ijzerman, who outlived his collaborator. Both the Linschoten Society and Ijzerman himself felt that the account already published was marred by an excess of heterogeneous details which, diverting the reader's attention from the main issues, merely served as a hindrance.

In the present volume Mollema, who in his own words is acting in the capacity of "a pilot steering us through the waters entered by Roufflaer and Ijzerman," describes in a first part, extending over 117 pages, the events which led up to the voyage and the circumstances which induced the recently formed shipping company Compagnie van Verre to undertake an expedition "which amazed the whole world." He gives biographies of the directors of the Company, the object of the voyage and the organization thereof, a study of the brothers Cornelis and Frederick de Houtman, details regarding the ships, their officers and crews and the conditions on board sixteenth-century vessels, particulars concerning the fate of the pioneers after their return, a description of the route followed by the ships, and an account of the quarrels between the two leaders of the little fleet, Cornelis de Houtman and Gerrit van Beuningen.

The second part, extending over 235 pages, is entirely devoted to a straightforward account (a kind of diary) of the voyage out and home of the two sister-ships *Mauritius* and *Hollandia* of 230 tons, the *Amsterdam* and the pinnace *Duyfken* (also described as a "yacht") from the moment when, on 2 April 1595, these vessels, carrying crews totalling 249, set sail from Texel, "bound for the Cape of Good Hope and . . . beyond," to 14 August 1597, by

which date the three that remained after the ill-starred *Amsterdam* had been abandoned and burnt were once more in the shelter of the home port.

Throughout, the author has striven to remain an impartial recorder of facts, anxious not to judge anything subjectively, or to appear to pretend that he, as a twentieth-century writer, is able fully to appreciate the mentality of his sixteenth-century forbears. The account is mainly in the Dutch of to-day, but in order to avoid presenting romantic history in a modern setting, which would rob it of some of its charm, Mollema has, wherever the sixteenth-century mode of expression appeared to him desirable in order to retain a suitable atmosphere, made use of that mode of expression, although he has for the most part adopted present-day spelling and has also, where it seemed expedient for the sake of clearness, modernized the syntax to some extent. The aim of the author—the production of a book calculated to give wider publicity to the work of his predecessors by means of a continuous account stripped of details of secondary importance—seems to have been fully attained. F. M. M.

THE GROWTH AND DISTRIBUTION OF POPULATION. By S. VERE PEARSON, M.A., M.D., M.R.C.P. *London: George Allen and Unwin* 1935. $9\frac{1}{2} \times 6\frac{1}{2}$ *inches;* 448 *pages; maps and diagrams.* 12*s* 6*d*

In his Preface the author remarks that "an understanding of the problems connected with the growth and distribution of population requires a knowledge of economics and psychology." He warns the reader that his conclusions differ from those of many previous writers, and that, in his view, wrong ideas have sprung up on such matters as over-population, restricted emigration, and differential birth rates. He rather disarms a geographer, however much the latter may disagree with him on certain elements of the subject, by emphasizing the geographical factor.

To take one important part of the subject, the relation between population and food supply, he is of opinion that "increasing crop yields can meet the needs of the increasing population of the world"; but, curiously enough, in his discussion of this problem, he nowhere specifically quotes Sir Daniel Hall's important investigation of the relation between population and available acreage, though he does quote Lord Bledisloe's opinion that Sir Daniel had under-estimated the power of research work in increasing the yield of wheat. It is obvious that Sir Daniel is the last man to under-estimate the value of science in its application to agriculture, and it would have been more satisfactory if the author had paid more attention to his investigation.

On a less debatable matter he approves of Professor Ellsworth Huntington's—he sometimes spells the name Hunting*d*on—statement to the effect that the main determinants of population are soil, relief, and climate, to which trio the author adds economic influences, pointing out the excellent circumstances of New Zealand, which is only sparsely populated because it is out of the way. He rightly stresses the fact that food production is of immense importance in connection with population questions, and that we should study to find out where the various food-stuffs can be most economically produced. But he also thinks that England should grow more wheat and still more should "produce more food-stuffs of other kinds. It would be healthier if more people took up such pursuits."

These matters are not easily solved. "French wheat production costs are two or three times those of Argentina and Canada." The cost of wheat protection—that is one of the difficulties. The author is apparently of opinion that this country could immensely increase its production of food. But though most of us would wish to see our home food supply, let us say, doubled, we think that

it will take a long time to reach such a desirable result, which can only eventually be attained through the patient application of scientific methods. We also think that there is a limit to progress in that direction, and that another factor, numbers, also deserves consideration. Great Britain is at the present time, in the matter of food, in a worse position than at the outbreak of the war. The military factor also deserves attention. The author mentions that no country circumstanced like ours is actually self supporting—as a fact we import about 62 per cent. of the food that we eat—"France, with a population density of 190 per square mile, comes nearest to this condition." And finally, "according to some," wheat growing can only be permanently successful "on the great plains of the world, such as North America, Argentina, Australia, and Russia."

That question of food supply is only one of the many topics which are dealt with by the author, often in an original way. He is not to be thought of as belonging to any of the regular political schools; he appears to disagree with all of them. "Even parties carrying the label Liberal vie with reactionaries and Socialists in restricting liberty and multiplying officials,"—so says our author. He has indeed a poor opinion of Government interference in most of the matters touched upon. Poor Governments! They are doing their best in a difficult world. Next to Governments he dislikes landlordism; and after landlordism, eugenics.

There is much of interest in the chapter on Town and Country Planning. The author remarks that "the number of professional people (including the lawyers, of course) who are earning fees by discussing and drawing up reports on town and country planning is rising rapidly and out of proportion to the accomplished results." He thinks that a main cause of ribbon development is "the natural temptation of landowners to capitalize the value that lies ready to hand in sites already furnished with good frontages and probably also with services. . . . Now if the principle adopted amongst primitive people that land is the property of the tribe had been recognized, and if the values given to land had always been employed in public benefit, there would have been no clash of private and public interests. . . ."

The book covers a wide field. The author discusses such matters as The Growth of Cities; Birth and Death Rates; Garden Cities; Housing; Emigration; all elements of a difficult subject. He has original remarks to make on most of these matters and though we may not always see eye-to-eye with him in his treatment of them, we shall most of us agree that intelligent opposition to generally accepted views may serve a useful function. C. F. C.

WORLD HISTORY: The Growth of Western Civilization. By R. FLENLEY and W. N. WEECH. *London: J. M. Dent and Sons* 1936. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xx+758 *pages; illustrations and maps.* 12*s* 6*d*

The aim of this work is to recount "the development of man from the earliest stages to the present day," concentrating upon the nations of Western Europe, but without neglecting other world civilizations and their contact with the West which has produced modern world history. Whether so wide a field can satisfactorily be covered by two writers is open to doubt. On many subjects they must obviously be merely summarizing the works of other authorities, and only the interest of observing the working out of a personal point of view will hold the reader's attention throughout. In this book however the writers have striven to eliminate much of this element, with the result that many pages are merely strings of facts, significant, no doubt, but set down without comment. In fairness it must be added that, as far as it is possible to check the mass of facts contained therein, they are accurate and well selected.

The first three parts were written by Mr. Weech, who gives a straightforward narrative of events to the decline of the Western Roman Empire. In a book of this type it is particularly valuable to have an up-to-date summary of recent advances of our knowledge of the early civilizations of the Middle East. The remainder, and by far the greater part of the work, is by Professor Flenley, who is obviously much more at home in the medieval section. The pressure upon the space allotted to the most recent history is probably responsible for his occasional failure to bring out the significance and inter-relation of events in different parts of the world. It would be difficult to gather from these pages any adequate idea of the great social and economic changes in the post-war world, and his references to world opinion and the League of Nations, though correct, are uninspiring. The attempt to include a survey of literary and artistic development has also proved too exacting: the sketch of English literature, except for a casual reference to Dickens and Thackeray, ends with Scott, though English painting is brought down to the Pre-Raphaelites. The drama is even more sketchily treated: but perhaps when a book already runs to nearly eight hundred pages it is ungenerous to ask for more.

A real attempt has been made to illustrate this book adequately and helpfully. The cartoons reproduced from *Punch* give an actuality to the narrative in the text, and there is a liberal provision of maps in colour and line. G. R. C.

MAN AND THE SEA: Stages in Maritime and Human Progress. By J. HOLLAND ROSE. *Cambridge: W. Heffer and Sons* (*London: Simpkin Marshall*) 1935. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xii + 288 *pages; illustrations and maps.* 10*s* 6*d*

The theme of this book is vast, ranging in time from Odysseus to the nineteenth century of our era; indeed, so vast that it may be doubted whether any writer without the accumulated equipment of a lifetime devoted to historiography could hope to handle it with success. Dr. Holland Rose is so equipped; and the result is a vivid outline which flows so easily from age to age that the casual reader might well fail to realize the wide range of reading which has gone to its making. The author has not set out to write a detailed history of maritime discovery. His purpose is to illustrate from significant examples the influence of man's long struggle with the sea upon his own development. "My guiding motive," he explains, "has been to correlate the efforts of shipbuilders, inventors, explorers, and statesmen, and thus to show how the world has been opened up for habitation." Naval wars are for the most part excluded, and the subject is limited mainly to the maritime peoples of Europe.

Perhaps the best chapter is the first, which is a running (and very suggestive) commentary on that sea-epic, the *Odyssey*. We are reminded that Homer's glorious fancy of a Blessed Isle somewhere in the unknown Western Seas exerted an incalculable influence upon subsequent exploration. Thence we pass on to the highly controversial question of whether the Phoenicians did in fact circumnavigate Africa about the year 1500 B.C. Dr. Holland Rose comes down strongly in favour of those scholars who uphold the credibility of Herodotus in the matter, though he fairly states the arguments of both sides in the text itself and in an appendix. The reader may however consider that the easiness of the East–West circumnavigation as compared with that in the opposite direction is somewhat exaggerated. After tracing the essentially local and territorial outlook of the Hebrews, the author points out how the transformation of the eastern Mediterranean into a Roman lake conduced to the spread of Christianity beyond the limits of a stereotyped Judaism.

The chapters on "the Conquest of the Atlantic" and "Spain the World Power, 1580–1640," tell a familiar story, but they tell it well and succinctly,

incorporating the results of recent research on many important points. The only major criticism one would venture to make here is that the reader is left with the notion that Spanish inefficiency at sea left her sea-borne traffic at the mercy of French, Dutch, and English marauders; whereas in fact the Spanish convoy-system, once it was established, rendered the annual Plate Fleet immune until the time of Anson. Subsequent chapters trace the work of Spanish, Dutch, French, and English explorers in the long search for *Terra Australis Incognita* which opened up the Pacific to European trade and colonization. A most interesting chapter accompanies this section on "Early Man in the Pacific" in which the structure of the canoes and sea-faring exploits of the various island races are described. Perhaps the darker side of the picture, the fact that the sea brought to these primitive peoples European disease and the disintegrating effect of European civilization, lay outside the author's terms of reference. In the exploration of this vast area the personality of Captain Cook and his work are rightly given the dominant position. In an appendix old slanders against him (long discredited by serious students) are given the *coup de grace*.

The narrative then turns to the titanic struggle between sea-power wielded by Great Britain and Napoleonic land power during the years 1803 to 1814. This chapter, which as an historical essay is perhaps the most valuable in the book, frankly seems out of place. The author is here dealing with a period and a subject on which he is of course a standard authority, and his treatment is accordingly learned and masterly. But although the effort of Napoleon to conquer the sea by the use of land power may appear to bear a superficial relevance to the theme, that struggle is essentially part of the history of sea-power as a political instrument. Viewed from that angle, the influence of the sea upon the destinies of man would call for a technical discussion of the reasons for the defeat of the Spanish Armada, the effect of the blockade of the Central Powers in the Great War, and much else of a like character.

The narrative concludes with a survey of the suppression of the slave trade. Drawing his material from a wide range of sources, the author traces the long and determined struggle of this country to induce a reluctant Europe (and America) to co-operate in stamping out this abomination. He shows that the struggle might well have been abandoned in despair but for the application of steam power to maritime transport. When the British Navy adopted the screw in place of the paddle, and slave traders, who perforce abandoned the sailing ship for steam, became dependent on coaling stations, the trade (to the American Continent at any rate) was doomed. V. T. H.

## GENERAL

THE TWILIGHT OF TREATIES. By Y. M. Goblet. Translated from the French by Warre Bradley Wells. *London: G. Bell and Sons* 1936. $7\frac{1}{2} \times 4\frac{1}{2}$ *inches;* viii+268 *pages; maps.* 7*s* 6*d*

This handy volume is well printed and illustrated by maps, and an excellent translation is provided for the English reader. M. Goblet has succeeded within the limited space of 260 pages in presenting a series of essays, covering nearly the whole of the modern world, which are remarkable for the wide range of knowledge and understanding they display. He claims in Chapter X "to have made a score of careful and objective analyses—some of natural phenomena, others of recent tentative experiments—with the object of arriving at a system of classification which has not so far been attempted. Analysis and classification: such is the task of contemporary political geography."

It may not be always possible to see eye to eye with the author in his conceptions of the political geography of the League of Nations. The growth of the League in this respect has been stunted by the pressure of its principal component parts so that, within the area of political geography, it has become little more than a convenient political instrument. He is not quite correct in stating in his opening chapter that the League decided upon the temporary organization of the Saar Territory and the creation of the Free City of Danzig. As a matter of fact, these two questions were taken up and regulated by the Council at Versailles before the League came into being, although their execution was entrusted to the League. M. Goblet regrets that the Saar could not have been continued under the League of Nations régime. It is true that, speaking generally, the governing commission appointed by the League Council administered the Territory in a competent manner and looked after the material interests of the inhabitants more effectively than the Reich could have done during this period. But the result of the plebiscite revealed that the experiment was no more than a temporary expedient, somewhat dangerously prolonged: it repeated moreover the lesson, which is sometimes forgotten, that an alien administration, however just and efficient it may be, cannot hold out indefinitely against national sentiment.

M. Goblet foresees the evolution of what he calls "synthetic states," and in Chapter X he cites Czecho-Slovakia, Iraq, and Manchuria as examples. His assertions and explanations are presented in a very lucid and skilful manner, but there is a large body of well-informed opinion in this country which will not assent to his views as regards the last-named of the three.

M. Goblet is probably quite correct in saying that "the tendency of our time—a tendency more or less marked—is to regard treaties, contracts, arguments, titles of sovereignty of every kind, as documents that must, from time to time, be brought into harmony with the evolving material with which they are concerned." The tendency is there no doubt, but it brings with it the danger—which may be sometimes extreme—of unilateral action in the repudiation of international obligations.

M. Goblet's ideas are stimulating and often provocative. His statements and arguments are well thought out and reasoned: moreover, they are singularly free from bias. E. C. W.

NORTH TO THE ORIENT. By ANNE MORROW LINDBERGH. *London: Chatto and Windus* 1935. $8\frac{1}{2} \times 5$ *inches;* viii + 248 *pages; illustration and maps* (by CHARLES A. LINDBERGH). 10*s* 6*d*

Mrs. Lindbergh has written an original type of travel book. Its subject is the flight which she made with her husband in the summer of 1931. Starting from Washington they flew by stages to Churchill, Aklavik, and Point Barrow; then turning south-westward, they roughly followed the Asiatic coast-line to Japan and China. The originality of the story lies in the point of view of its author. She is not concerned with the significance of the trip: to her it was a romantic voyage by the north-west to Cathay. She was not a passenger, for she took her turn at the controls and was in sole charge of the wireless equipment. But since the flight was carried through with that almost mathematical precision one has learnt to associate with all Colonel Lindbergh's ventures, she had time to observe and record the things which most interested her. From one who in a few weeks has flown many thousands of miles it would be natural to expect generalizations. We do not get them. Instead we are given clear-cut pictures of the hectic thrill of departure, an evening in a trappers' outpost, an Eskimo dance, of the difficulty of talking Japanese from a phrase book, and of the

horrors of a Chinese flood. A series of cinematograph "shots," tastefully and cleverly directed to show different aspects of life between New York and Hankow, would be a simile to describe the main part of 'North to the Orient.' The rest, the connecting links, are descriptions of arduous or exciting hours of flight, staccato wireless messages, and the simply-drawn maps which act as chapter headings.

This is not an important travel book; but it is very pleasant to read, and it is well produced. J. M. S.

AMONG THE WATERFALLS OF THE WORLD. By EDWARD C. RASHLEIGH. *London: Jarrolds* 1935. $9\frac{1}{2} \times 6$ *inches; 288 pages; illustrations and plans.* 18*s*

Thanks are due to the author for having undertaken the task of compiling this book so as to preserve descriptions and photographs of the most famous waterfalls of the world before they have been sacrificed wholly or partially to the march of progress and diverted for irrigation or power. The Shoshone Falls "the third of the most notable North American cataracts" is destroyed, Niagara is harnessed; the Grand Falls of Labrador will soon share its fate; by 1937, one reads, the Victoria Falls will also probably be utilized though every care will be taken to preserve their beauty. It is indeed time that details of their original splendour should be available, and in this volume we find accounts of all the more notable waterfalls of the world, together with their histories and the figures (engineer's figures where possible) setting forth their volumes and dimensions. Some descriptions are from personal knowledge, as is particularly notable in the case of the Augrabies Falls. Books by well-known authorities are freely quoted as are reports and articles, while ultimate conclusions are clearly stated as well as differing opinions. But lest statistics tend to weary they are accompanied by fine descriptions of beauty and grandeur and by legends and superstitions preserved by natives for whom some fall's stupendous force embodies the supernatural.

No fall is included which has a vertical leap of less than roughly 50 feet, yet between two and three hundred find a place, the highest being the Sutherland Falls in New Zealand with a drop of 1904 feet in three leaps. Surprises may be encountered. Most people if asked would unhesitatingly name the two or three of the world's great falls which they considered carried the greatest volume of water. But how often would the Guayra Falls be one of them? Yet we read that these falls on the Alto Parana have an average mean flow which "exceeds the combined mean volumes of Niagara, Paulo Affonso, the Iguazu Falls, the Grand Falls of Labrador, the Victoria Falls of the Zambezi and Kaieteur rolled into one." And readers might even admit to themselves perhaps that they had never heard of the Paulo Affonso on the Francisco river in South America, yet it takes "third place as regards mean annual volume of the great falls of the world, Guayra and Niagara alone surpassing it." The inexpert reader will find much to learn and the expert reader a wealth of detail. The 274 photographs collected from many sources are most beautiful and valuable.

E. W. N.

# THE MONTHLY RECORD

## A NEW MAP OF GREENLAND

The Geodetic Institute of Denmark has issued the first six sheets of a 1 : 250,000 map of Greenland. A few sheets had already been published in another style; these showed the neighbourhood of Disko Bay and the country near the settlements of Godhavn and Jakobshavn in West Greenland. They were excellent of their kind and indicated the length to which Denmark is prepared to go in administering a colony from which little economic profit can be expected.

The new map replaces the former publication. The brown tint covering the land is not so dense as formerly and the tracts below 200 metres are coloured green, which corresponds with the landscape itself in summer. Ice is indicated in blue and its form shown with contours. There is hill-shading with vertical lighting by some process similar to chalk on stone. It is interesting to note that the blue plate carries the coast-line, all water and ice-names, and the graticule. The general impression given by the map is clear and bright and the student will have no difficulty in getting from it a good idea of West Greenland.

If any criticism is to be made it should be directed towards the lettering, particularly to the large serifed capitals indicating principal settlements (*e.g.* Jakobshavn) and to the sans-serif letter used to indicate territories (*e.g.* Arve Prinsens Ejland). The rest of the map in plan and execution reaches a high standard and the printing and registration are remarkably good.

M. A. S. and D. R. H.

## THE GEOGRAPHY OF GUATEMALA

Our knowledge of the geography of Guatemala is largely due to travellers primarily interested in archaeology. A good example of this type is 'A Glimpse at Guatemala,' by the late A. P. Maudslay. The numerous studies by Professor Karl Sapper, who also produced a map of the country, are an exception. No systematic geography has been written lately, so that the publication, in the *Mitteilungen* of the Hamburg Geographical Society, vol. 44, 1936, of Professor F. Termer's study of the physical geography of Central and South Guatemala is to be welcomed. This is to be followed by a further study of the human geography, thus completing the results of extensive journeys in the years 1925 to 1929.

The essay opens with a general sketch of the natural regions, in which their characteristics, contrasts, and the difficulties they present to the traveller are vividly portrayed. One feature of the geography is the existence of great numbers of small contrasting individual regions, but these can be grouped roughly into seven main divisions, the determining consideration being the surface formations—*e.g.* the rugged mountain chains of the west coast, the volcanic formations of the "Altos" of the south-west, and the karst areas of the central mountains and the western portion of the Altos Cuchumatanes in the north-west. Professor Termer deals in greater detail with three areas of which little was previously known: the Sierra del Mico and Cerro San Gil mountains of the north-east; the Altos Cuchumatanes; and the non-volcanic range of the west—the Sierra Madre. The Altos Cuchumatanes are an extensive plateau, rising abruptly on all sides but the east. The western and eastern sections are distinct in geology and tectonics; the west is a rolling limestone plateau, with well-developed and striking erosion forms, practically waterless and uninhabited. In the east, the limestones have been removed, exposing sandstones

and clays; in many places the rivers have cut cañons, and a great part is still covered by virgin forest.

The author, by filling up the gaps in Sapper's surveys, has produced a topographic map of Guatemala and San Salvador on the scale of 1 : 300,000, but is unable at present to publish it. His monograph is well documented with references to previous workers, and contains a sketch-map of the Altos Cuchumatanes and two geological profiles.

A number of American geographers have also been at work in Guatemala. The *Anales* of the Geographical and Historical Society of Guatemala for March 1935 contains articles by Professor W. W. Atwood and Dr. R. S. Atwood on the volcanic region of the south. The former concentrated upon the physiographic problems presented by the great beds of volcanic ash mainly in the Lago de Atitlan area. These beds, originally transported by wind, are subject to constant erosion, so that they are continually moving downwards, to the destruction of the cultivated lands of the Indians—though this is compensated to some extent by the formation of small alluvial patches of great fertility. Professor Atwood distinguished an older series of beds, laid down upon a developed topographic surface, and giving evidence of two cycles of erosion. The great Lago de Atitlan he considers, following Dr. Tempest Anderson (see *Geogr. J.*, May 1908), to be a caldera, from the evidence for faulting, the inclination of the cinder beds away from the lake, and the instability of the lake-level. (Two photographs published by Professor Termer show that the level fell 8 metres between 1904 and 1927.) R. S. Atwood gives a brief summary of investigations into the human geography of a portion of this volcanic region, centring in the town of Chichicastenango, some 15 miles north of Atitlan, and outlines a scheme for future research. The fertility of the soil has made an area of relatively dense population, the villages being distributed in two main groups, one along the outer lower edge of the belt where water is plentiful, the other in the more elevated part, where the greater fertility of the soil is compensation for the abruptness of the topography (slopes up to 40° are cultivated). A similar study by W. McBryde on the neighbouring market centre of Solola was reviewed in the *Journal* for June last.

It may also be mentioned that two recently issued sheets of the Million Map of Central America published by the American Geographical Society (N.D.-15, Ciudad Guatemala, and N.E.-16 Belize) cover a great part of Guatemala. The layer colouring brings out the contrast between the range and valley topography of the interior and the volcanic "Altos." The innumerable streams of the Pacific slope rather obscure the other details, and in general the selection of names appears to be very generous.

## AWARD OF THE GEOGRAPHICAL ESSAY PRIZE

In the *Journal* for June 1933 it was announced that the Council of the Society had resolved to offer a prize of Ten Pounds annually for an Essay of not more than 5000 words: either a critical survey of recent additions to knowledge in a limited geographical field selected by the writer, or a discussion of some current problem in its geographical aspects. Competitors for the Prize must be registered Internal or External Students reading for Honours in Geography at one of the Universities of Great Britain and Northern Ireland during the academic year within which they submit their Essay. Essays must be submitted during the month of December, the award will be made not later than March 31, and the Prize Essay will be published in the *Geographical Journal* for May or June following.

Thirteen Essays were submitted in December 1935 and the prize was awarded

to Mr. R. W. Steel, student of the University of Oxford, whose essay on "The Trade of the United Kingdom with Europe" appears in this number of the *Journal*. Essays in competition for the fourth award of the prize should be addressed to the Secretary of the Society by 31 December 1936.

## TRAVEL IN THE SAHARA

The following letter has been sent to the Society by a Fellow who received it from Mr. G. I. Jones of the Nigerian Police, who crossed the Sahara on his way home in the autumn of 1935. The letter shows to what a great extent travel in the Sahara has developed in recent years and how the desert, which was once considered practically impassable, is on the way to becoming an international highway.

"The trip proved a great success and I am resolved to repeat it each time I go on leave. The scenery especially in the Hoggar is magnificent, but all of it is good; you cover about 200 miles a day or so, and as you are proceeding from south to north practically each day you pass through a different type of country. There is no difficulty about finding the track and wherever the country gets broken the French have constructed a good road. If one fits super balloon tyres one has no difficulty with sand. If you are in a hurry you can get from Kano to Algiers in ten days, stopping every night except the first at a hotel of sorts. If you break down you wait for the bus or until they send out a break-down car from the next post. Of course one sees nothing of the people living in the country, but one never does unless one lives amongst them and can speak to them in their own language. But as far as we were concerned after eighteen months spent amongst people crowded as many as 1000 to the square mile it was the almost complete absence of people that appealed most to us. My camera let me down, as I employed a cheap German exposure meter which couldn't cope with the brilliance of the light.

"Picturesqueness and variety were supplied at most of the stopping places by the Europeans we met there. Two English girls at Agadez driving a motor cycle and side-car to the Cape and stranded there with a big end gone. Three Frenchmen driving a Hispano-Suiza to the same destination stranded at In Guezzam with a broken gear-box. A French girl at Tamanrasset with a 10-horse-power Renault and a bulldog come out to see her lover at Kidal and refused permission by the authorities to proceed farther alone. She defied them and left at midnight and got to Kidal the next day—fortunately for all concerned. Three Swiss with a cracked cylinder head at Arak intent on climbing the Pic Liman and armed with ropes, crampons, hammers, nails, hooks and all the latest rock-climbing devices. We heard later that they got most of the way to the top on camels. Two Germans a little farther on who irritated us beyond measure by watching us with great interest while we made a stone causeway across the river-bed (which still contained water) and when we had finished calmly started up their car and drove across it. The family chaffeur of the Hispano-Suiza owner speeding in another car hired from the Bus company to his master with a new gear-box and held up at In Salah because of the rain in the Arak valley; and last an English girl and man in a Riley bent on making a new car record to the Cape and stuck in the snow at Djelfa behind Algiers.

"Archaeologically I found a lot to interest me and a trained archaeologist would probably have found much more. At Tamanrasset I met a Belgian sergeant in charge of a Meharist corps who spent most of his time patrolling between Tamanrasset, Agadez, and Kidal. His hobby was the collection of stone implements, and he showed me a large collection he had made for the Brussels Museum. From his account the triangle between In Abangharit, In Guezzam,

and Tinzahouaten is thick with them. I picked up some arrowheads, a scraper, and a neolithic axe outside the Cderj at In Guezzam myself. There is also a burial ground there consisting of large cairns of stones which the sergeant when I mentioned it contemptuously termed modern. But modern with him appeared to represent anything that was not palaeolithic."

## MOUNT EVEREST EXPEDITION

Despatches from the Mount Everest Expedition 1936, published every few days in the *Daily Telegraph*, record a satisfactorily uneventful journey across Tibet and the successful establishment of the Expedition in good time at the intended camps up the East Rongbuk Glacier to the North Col. Our paragraph in the *Journal* for May took the account to Tenkye Dzong, but it now appears that the date Sunday April 19 there given was a week late. Wireless communication was not established on the march and the message from Tenkye was sent by runner. Letters and despatches from Mr. Ruttledge, dated Tenkye, Saturday April 11, have since been received and the Expedition was to leave that camp on Monday April 13. The date of arrival at Base Camp has not been reported, but it was evidently within a day of Friday April 24 as intended; perhaps a day earlier, since a message received on Friday May 1 stated that wireless contact was established and that Smijth-Windham and Gavin had occupied Camp I on Monday April 27. The remainder of the Expedition were then at Base Camp all fit after an easy march in splendid weather. The whole party must have moved up to Camp I immediately afterwards, for a despatch on Monday May 4 from Camp I stated that the entire party were engaged in stocking Camp II, which would be occupied on Wednesday May 6. The weather was still exceptionally mild and slight disturbances were no hindrance. Owing to advanced acclimatization, the fitness of the party and favourable condition of the mountain, it was expected that the advance from the North Col for the first assault would begin about Sunday May 17 if the favourable conditions persisted and weather forecasts from Calcutta were encouraging.

For proper interpretation of succeeding messages it will be convenient to quote from the General Plan of Operations drawn up by the leader at Gangtok, dated March 17.

The base of the Expedition will this year be Camp I which, to avoid confusion, will continue to be called by that name. It will be the headquarters of the Transport and Wireless Officers. Camp II will be placed in the medial trough at a position noted during last year's Reconnaissance. It will not be permanently occupied. The Expedition headquarters during operations will be Camp III to be established near the site of the 1933 food-dump (that is to say nearer the foot of the North Col slopes) and was to be occupied not later than Friday May 15 by the leader, the chief Medical Officer, and the whole of the climbing personnel. The route up the North Col would then be made and Camp IV stocked with everything needed there and higher up. Communication with wireless headquarters at Camp I would as far as possible be maintained by short-range portable wireless equipment.

On Sunday May 10 Mr. Ruttledge reported that Camp II was fully established on May 6 at a new site in the main trough of the East Rongbuk Glacier, thus avoiding all crevasses. On Thursday May 7 Smythe and Shipton, with porters, established Camp III at the new site not far from the foot of the North Col slopes at about 21,500 feet. The main party had on Sunday May 10 joined them there, all very fit, and in two days' time (that is by Tuesday May 12) the Camp would be completely stocked with everything required during operations on the mountain. Wireless communication had been established with Camp I,

but with difficulty owing to the configuration of the mountain. On Saturday May 9 Smythe, Shipton, and Warren, with the best porters, had worked out the route more than half-way up the North Col in fair conditions, but snow during the night had prevented the resumption of the work.

On Thursday May 14 Mr. Ruttledge reported from Camp III that after delay due to snowfall the route up the great ice face of the North Col had been completed on May 13 by Smythe, Oliver, Wigram, and Gavin and eight picked porters. Steps were cut and ropes were fixed most of the way up. The route is steep but reasonably safe from avalanches. Wyn Harris and Kempson had started on Thursday May 14 with forty-six porters for the North Col and it was hoped that Camp IV would be completely stocked on the following day. If possible Smythe and Shipton would occupy it with porters. The weather was marvellously quiet, but there was rather too much snow on the mountain.

On Saturday May 16 the Leader reported that the party under Wyn Harris and Kempson had made a most successful carry. The route laid out to the North Col is in places very steep ice and snow but remarkably safe from danger of avalanches. The porters went up splendidly and only one of the forty-six was unable to face the steepness of the final section. The tents have been pitched on the ridge itself close to Shipton's ruined tent of last year. On the following day, Friday May 15, Smythe and Shipton with forty-one porters occupied the camp on the North Col, made on the preceding day with the intention to begin the advance up the northern ridge within a day or so if weather permitted. Wyn Harris, Kempson, Warren, and Oliver were to occupy Camp IV in support on the day the first party advanced, and were to form the second and third assault parties. Camp III was in good wireless communication with Camp IV.

Up to this point the weather had been described as marvellously quiet, and there had been little interruption to the orderly process of establishing the mountain camps; but it was too much to hope that this would continue without a check. On Monday May 18 Mr. Ruttledge reported from Camp III that heavy snow had interrupted the advance. There was 15 inches on the North Col, which would itself not be safe for perhaps two days. There was plenty of food on the North Col and the advance party were there in splendid comfort. A violent wind was tearing new snow from the upper face of the mountain, which gave some hope of an early resumption of the advance. There was no news of the monsoon.

But later on the same day, Monday May 18, Mr. Ruttledge reported that he had been in consultation by high altitude wireless with Smythe and had decided that it was safest to evacuate Camp IV temporarily as further snowfalls were probable. Smythe and Shipton with all the porters had just arrived at Camp III after a well-judged descent in difficult conditions, when the slightest error would probably have resulted in heavy avalanches. It would be necessary to wait until the snow cleared from the mountain.

The conditions did not improve, for on Thursday May 21 Mr. Ruttledge reported from Camp I that after very careful consideration of the position he had decided to bring the whole party down there for a short rest, since the recent heavy snow had rendered the upper slabs of the mountain temporarily unclimbable and they were likely to remain so for a week or ten days. The party was in good condition except for one or two sore throats, but would be stronger for a week or so at a lower altitude. The Meteorological Department reported the approach of the monsoon in the south of the Bay of Bengal. The climb would be resumed whenever the snow showed signs of clearing, and Mr. Ruttledge estimated that owing to good acclimatization it would be possible to reach the summit in eight days from Camp I.

On Monday May 25 Mr. Ruttledge reported from Camp III that conditions had been extremely baffling. The monsoon first reported forming south of the Bay of Bengal on May 19 had actually arrived at the Darjeeling hills on the 23rd and apparently advanced to Mount Everest on May 24, when heavy snow fell. The snow due to Western disturbances earlier in the month had never left the mountain, the unusually gentle wind having been insufficient to remove it. He had brought the party up to Camp III again to be ready, but would not invite disaster by premature advance while the North Col slopes were dangerous. Avalanches were falling on May 25. He must hope that the abnormal monsoon would be followed by a quiet period of which advantage could be taken.

All the messages from the Mount Everest Expedition summarized above are the copyright of the *Daily Telegraph*.

In an Appendix to a recent paper on the 1935 Reconnaissance Mr. Spender wrote:

The front of the monsoon is not a definite thing: it is rather a zone in which disturbances from the main monsoon advance and retire and traverse. In Mount Everest literature the "break" of the monsoon is a term usually employed to mean the instant of arrival of the first of these skirmishing disturbances. From that time onwards, of course, similar disturbances are likely to come up from the plains, bringing snow and cloud. But it may be some time later that the great body of warm air reaches the highest Himalaya. And there may be a longish period of fine weather between the first storm and the arrival of the deep mass of monsoonal air.

But with the weakness of the westerly current this year there may be less than normal resistance to the approach of further disturbances in advance of the main monsoon.

## MEETINGS: SESSION 1935–36

Fourteenth Evening Meeting, 4 May 1936. The President in the Chair

*Elections:* David Fenwick Albert; Mrs. E. Balfour-Allan; The Reverend E. J. T. Bagnall; Admiral The Rt. Hon. the Earl of Cork and Orrery, G.C.V.O., K.C.B.; Anthony Ponsonby Dudley Hill; Antony Howey; Hedley Herbert Marshall; Robert Rankin, M.P.; Douglas William Stevens, A.R.P.S.; The Reverend Howard R. Rokeby-Thomas, B.SC., F.C.I.

*Paper:* Persia in 1935. By the Baroness Ravensdale

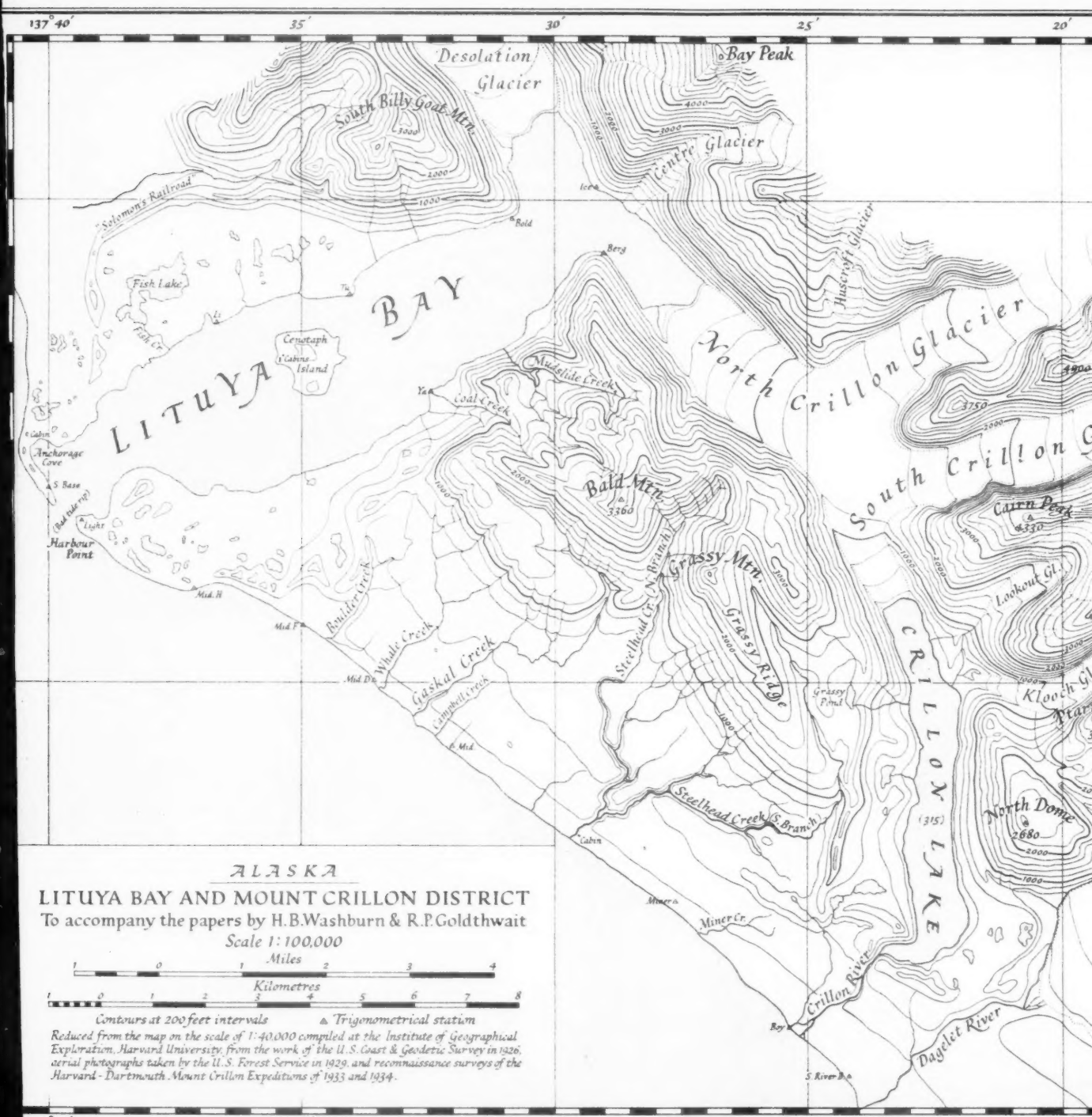
Seventh Afternoon Meeting, 11 May 1936. The President in the Chair

*Paper:* Photographic Surveys in the Mount Everest Region. By Mr. Michael Spender

Fifteenth Evening Meeting, 18 May 1936. The President in the Chair

*Elections:* Waris Ammer Ali; Miss Mary Gladys Bolton; Miss Margery A. Clerk, B.A.; Ian Herbert Cox; Henry James Hamilton Drummond; George Fitzpatrick; Ronald Kay Gresswell; David Hay; Mrs. Nina E. Hayes; Leonard C. Dundas Irvine, M.R.C.S., L.R.C.P., M.B.; The Hon. Mr. Justice James; K. Thomas Joseph; Alfred Samuel Juniper; Roger Loch Marks; Wilfred Oliver Naylor; Lieut.-Col. Harry Egerton Norton; Fred Rowland; Robin Thomas; H. J. van Buskirk

*Paper:* The Third Commission of R.R.S. *Discovery II*. By Dr. N. A. Mackintosh




ALASKA

## LITUYA BAY AND MOUNT CRILLON DISTRICT

To accompany the papers by H. B. Washburn & R. P. Goldthwait

Scale 1: 100,000

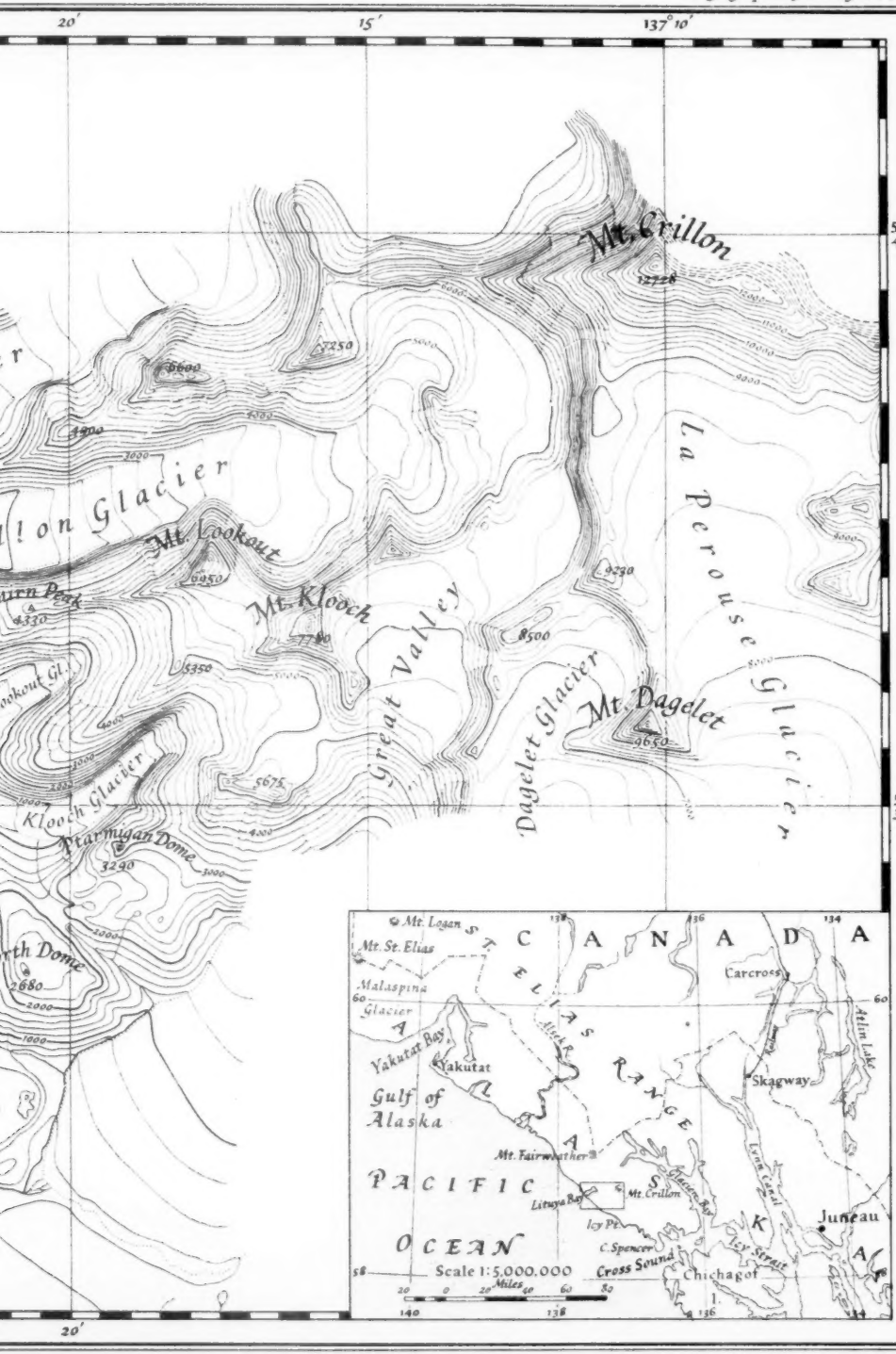
Miles 1 0 1 2 3 4

Kilometres 1 0 1 2 3 4 5 6 7 8

Contours at 200 feet intervals ▲ Trigonometrical station

Reduced from the map on the scale of 1: 40,000 compiled at the Institute of Geographical Exploration, Harvard University, from the work of the U. S. Coast & Geodetic Survey in 1926, aerial photographs taken by the U. S. Forest Service in 1929, and reconnaissance surveys of the Harvard - Dartmouth Mount Crillon Expeditions of 1933 and 1934.

Published by the Royal Geographical Society




LITUYA BAY & MT. CRILLON DISTRICT
Washburn and Goldthwait